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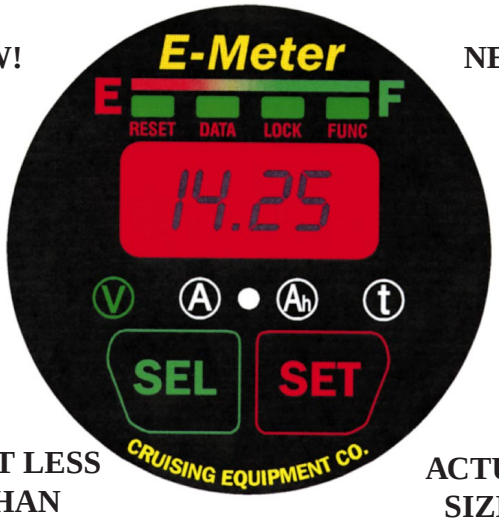

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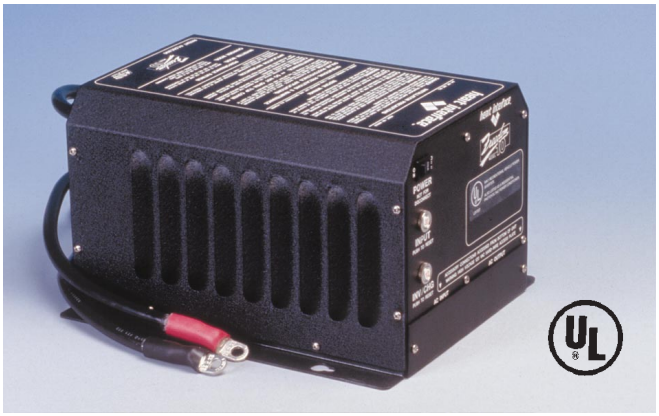

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THE HANDS-ON JOURNAL OF HOME-MADE POWER

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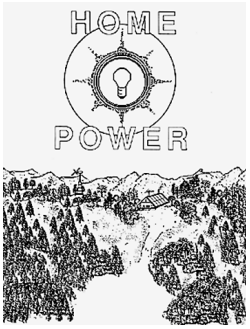

Features

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Fundamentals

Features

Cover: Solar electricity provides lights at night in rural Vietnam. Photo by Marlene Brown.

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Above: Home Power Central on Agate Flat, Oregon. Photo by Richard Perez

Everyone told us we were nuts when we started Home Power eight years ago. The consensus in the RE industry then was that no one wanted or could afford home-sized systems.

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We've come a long way. And we still have far to go. The next step is putting independently produced RE on our electric grids. If we made it this far, then we can do this too. Richard Perez for the Home Power Crew

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Michael Welch
John Wiles
Myna Wilson
Jeffrey Yago

" Think about it…"

"He who knows that enough is enough will always have enough"

Lao-tzu

SOLAR DEPOT

FULL PAGE
four color
on negatives

this is page 5

Solar Electricity in Vietnam

Marlene Brown

Above: Puttting up the community center system, Phu Tan Commune, Tien Giang Province.

Right: Transporting equipment to the different houses by boat, Long Hoa Commune, Trah Vinh Province.

Nothing can prepare one for a country like Vietnam! While my visit there was anything but typical, I was able to see and experience Vietnam as it really is. The people were warm and friendly and genuinely wanted to know “foreigners”. To them, the past is past and they have moved forward in their lives. Although various wars have devastated their country, none have harmed their spirits. The gentleness of the people and the welcome they offer is enchanting.

I made my first visit to Vietnam in December of 1994, to manage a solar PV installation project for the Solar Electric Light Fund (SELF). The project was a joint venture between SELF and the Vietnam Women’s Union (VWU) to install 100 small, one-panel, one-battery systems using the Uni-Kit II package manufactured by United Solar Systems Corp. of Troy, Michigan. These systems were to be installed by locally trained technicians, in locations chosen by the VWU. SELF would provide the materials and the expertise and the VWU would provide the people to be trained as the technicians and “motivators”, to sign up families who would receive the systems, and set up a revolving credit fund designed by SELF. The VWU would also be responsible for bringing the equipment through customs and transporting to the various sites. Further in-country technical assistance would be provided by Solarlab, a small group of physicists based in Ho Chi

Minh City (HCMC). They had already completed a number of successful PV projects, mostly solar battery charging stations. They were an important component of the project and became invaluable.

The project officially started a few days after I arrived, when Mme. Phuong and Mme. Sam from the national headquarters of the VWU, based in Hanoi, arrived in HCMC. Mme. Phuong brought me roses and we exchanged formalities and then got right down to business. Throughout the meeting, I expressed the wishes of SELF regarding what tasks would have to be accomplished while waiting for equipment and before any work could begin. They had a copy of the Project Agreement negotiated by SELF's President, Neville Williams, in Vietnam the previous July. They knew what needed to be done and already had many mechanisms in place for the project they called "Solar Electricity for Rural Women and Children." They had trained "motivators", sent them out to the various communities, and had families signed up to receive small residential systems. The IEC (Information, Education, Communication) material was prepared by the VWU, including an owner's manual translated into Vietnamese.

SELF had originally approached the VWU in February in Hanoi, to see if they were interested in helping to bring electricity to some of Vietnam's 60 million people (out of 72 million) who had no access to grid electricity. They were. The VWU has 11 million members and is one of the most powerful and effective organizations in the country. The major funding for this project was provided by a grant from the Rockefeller Brothers Fund, and a contract with Sandia National Laboratories' Renewable Energy Design Assistance Center and the U.S. Department of Energy.

Training

Within the next few days, the training started at a school just outside HCMC. They brought students from each of the four selected communes in the south. Some were from the district and some from the province in which each commune was located. (The term "commune" is still preferred, rather than "village". A commune is a collection of small hamlets.) There were 10 students and Mr. Luu, who was hired by SELF, interpreted. The whole process was a learning experience. In order for Mr. Luu to translate correctly, he had to clearly understand what I was saying. I had prepared a training manual previously, but found that only the most basic information was applicable to the training, as the students didn't have any previous background in solar or any other technical applications. I realized that most of my material was too technical for them, and rearranged what I taught to make sure the students understood the most important concepts about solar and electricity. Mr. Luu explained to me that the training had to be slow and clear, so we took lots of breaks and went over concepts many times.

The students liked my "American teaching method." I

Below: Putting up the panel with help of the community, Long Hoa Commune, Trah Vinh Province.

would teach for a while, take a break and then ask each student a question. They were all very sharp. Mr. Luu and I would try to trick or confuse them, but they would always give the correct answer. Almost immediately I knew that they were capable of this project and I had complete faith in them.

Five communes in three provinces were to be beneficiaries of this project. At the time I was in Vietnam, training and material was only available for four communes in two of the provinces in the Mekong Delta in the south. The fifth commune, in Nghe An Province, is in the north and had material delivered for installation in late 1995.

Delivery of Materials

The equipment, which had been shipped by sea from the U.S. well over a month before I left, arrived during the training of the technicians. The VWU told me that after the training was completed the technicians would ask every day where the materials were. They didn't understand the process the equipment had to go through before it could be allowed into the country. After waiting a week, we were finally allowed to collect the equipment. I was terrified as I watched the customs representatives open boxes. I kept telling these folks to go slow and take it easy because some of the equipment was fragile. They respected my wishes and even left some boxes unopened, probably because of the crazed American woman! Anyway, the equipment arrived safely at the VWU offices, and within a few days the rest of the equipment arrived by air.

Batteries

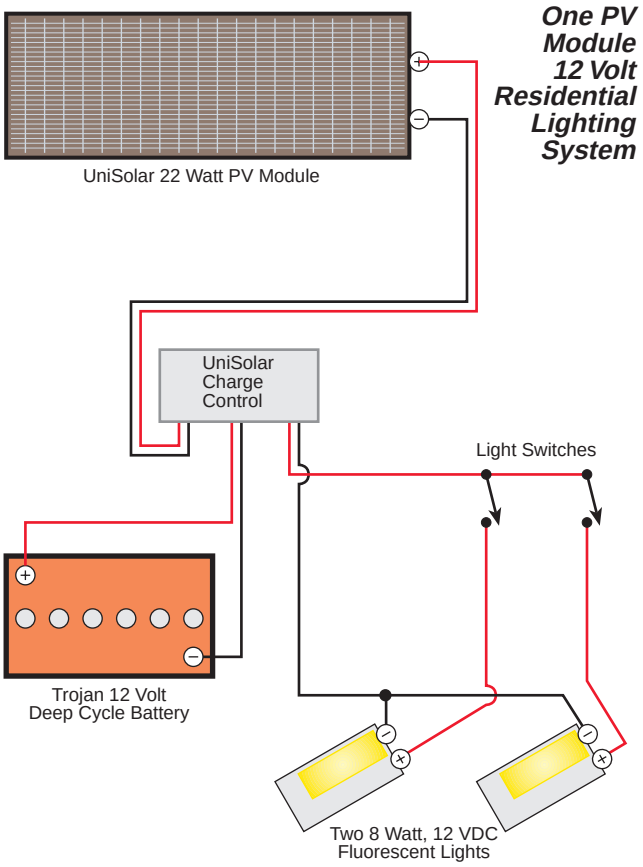
The next obstacle after getting the materials was finding someone to fill and charge the Trojan 70 Ampere-hour batteries. Since batteries are essential to the PV system, it was important to find someone to do the job who was capable and reliable. I found a battery company which was regularly used by Solarlab. I met with them and they were a good candidate for the job. They were familiar with deep-cycle batteries and could charge the batteries at the offices of the VWU. I had the battery company give a warranty to the VWU, who will have to work with them if there are any problems with the batteries in future. Those batteries that were checked were charged sufficiently and were in good condition. One extra battery was left in each commune as a spare in case of any problems. So far, there have been no problems related to battery failure.

The Systems

100 small residential home systems were completed in four communes in two provinces in the Mekong Delta in the south of Vietnam. Each Uni-Kit II system contained one 22 Watt amorphous panel, a frame, wire

Above: Transporting packaged system from Trah Vinh Town to Long Hoa Commune, Trah Vinh Province.

with integrated plugs to keep the polarity correct, a charge controller, and two 8 Watt lights. We had to make two fundamental changes to each system. One change was to the frame. Since the houses were made out of bamboo and rebuilt every few years, the frame was changed to put the panel on a pole next to or attached to the house. The other change was the use of external switches which turned out to be an ideal way to install the systems. Because the ceilings were quite high it was impractical to turn the lights off from pull chains attached to the lights. It was more convenient to switch the lights off individually from wall-mounted switches. One of the two plugs provided for the load on each controller had to be cut so that external switches could be connected to the system. Manufacturers should include external switches as standard in their kits.



One PV Module 12 Volt Residential Lighting System

Five community center systems were also installed by Solarlab. I supervised the installation of two of the systems and some of the technicians were able to help with the installation. Four of the systems were basically the same. They consisted of three Siemens PC4 75 Wp panels and a charge controller built by Solarlab. Local deep cycle batteries were used. The frames were built by Solarlab. Wire was obtained locally. Each system was equipped with eight 20 Watt fluorescent lights produced in Vietnam by Solarlab. The systems were also used to power televisions, and VCRs in the future. The charge controller was set up with a feature to switch between two separate battery banks. After the community center battery bank was fully charged, the switch could be flipped to charge batteries from local households. All systems were 12 volts.

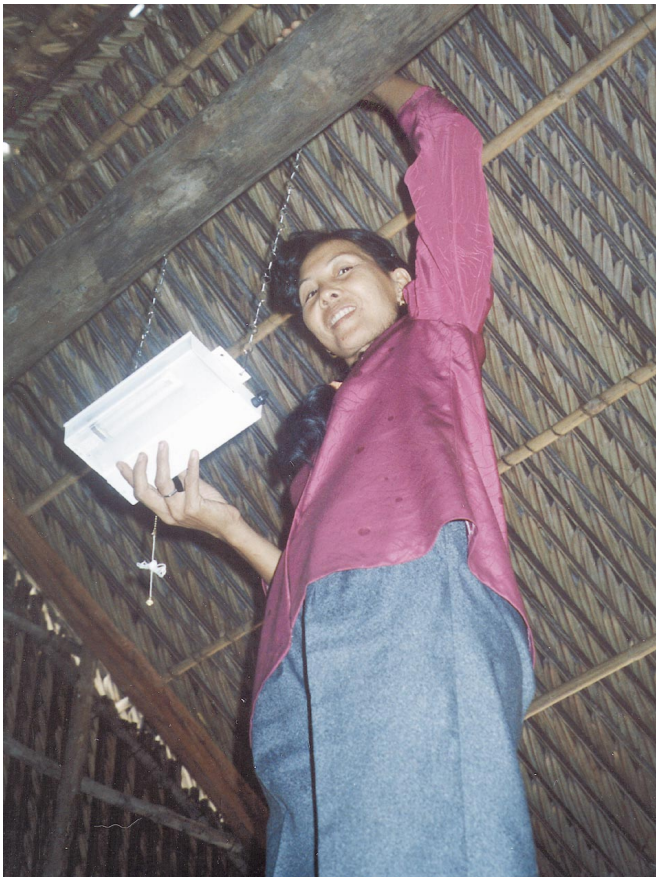
The fifth community center system was the same except for the panels, which were six Volt, 495 Wp panels donated to the project by ASE Americas (formerly Mobil Solar). These panels were huge, hard to transport, and even more difficult to mount, but much appreciated. They were ground mounted with a strengthened frame built by Solarlab. The charge controller, batteries and lights were the same as above. This system was set up in Phu Dong Commune in Tien giang Province.

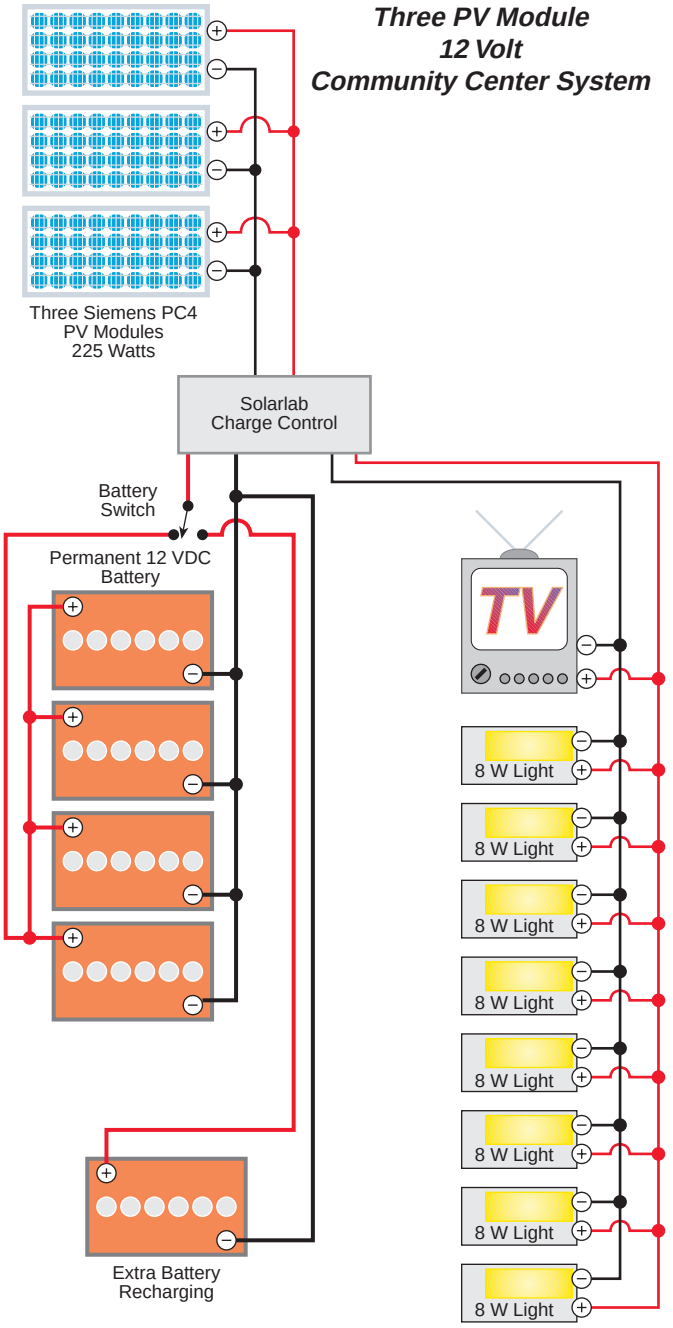
Extra Equipment

We encountered a number of problems when it came to actual installation, and manufacturers should take these into consideration if they want to participate in the third world market. The kits we used were geared for installation in an environment common in the U.S. but not in the third world. Apart from the changes already mentioned, we needed all kinds of extra equipment. Extra plugs, more wire ties, nails (not screws), different sizes of wire nuts, some type of chain and hooks to hang the lights, some electrical tape, and more than one extra fuse should be included with every kit. If a kit is sent to a developing country like Vietnam and reaches a community without the aid of an "international expert", none of these items would be available, except in the cities. Items such as wire nuts were not obtainable anywhere, and I spent a lot of time trying to find them.

It doesn't matter how much time is spent in preparation, there is always something that will inevitably be left behind. The most important information I could give anyone going to Vietnam and especially a remote area is if you want something in

Below: Women's Union representative installing a light. Phu Dong Commune, Tien Giang Province.





Three PV Module
12 Volt
Community Center System

particular with you at the job site, bring it with you. General electrical tools such as screwdrivers, lineman's pliers, wire cutters, crimpers, and hammers can be bought on the streets of Ho Chi Minh City and many other small cities. DC car fuses and electrical tape are easily obtained also. One item I never found was wire nuts. If you want to use them, bring lots with you. If you need to drop some voltage from a 12 Volt system to a 9 Volt radio or whatever, you should bring a variable resistor or some type item that will accomplish this task. Diodes are available, but you will be soldering them together by hand and somehow wiring them into

Above Top: Technicians installing controller and switches, Phu Dong Commune, Tien Giang Province.

Above: Technicians assembling panel to the frame, Phu Dong Commune, Tien Giang Province.

the system, which is what I did. Another difficulty was finding chain to hang lights. Here in the US, finding hooks and chain is not a problem. Even in the big city, I resorted to going to the animal market and after many hours with a Vietnamese interpreter, it took many days to get 100 meters of chain. I wanted to be able to cut the chain in the Communes, because all the houses are built a bit differently and I wanted to accommodate the homeowner as much as possible in the placement of the lights. Other items to bring would be one multimeter for every two technicians (at least), inclinometers for setting the correct module angle (15 degrees), wire ties, and some type of clamps or hooks to hang wire on the walls. Compasses were extremely hard to find. The only ones I could find were the overpriced fake US army issue or ones with Russian letters. It is best to get lots of these at home and bring them along. Also, make sure you give the same items to all technicians or groups of technicians. Getting work done will go much smoother.

Work Completed: Trah Vinh Province—Long Hoa and Hoa Minh Communes

The remoteness of Long Hoa was remarkable—it took seven hours by car from Ho Chi Minh City to reach Trah Vinh town, the capital of the province. Here we met with Miss Hain, the head of the VWU for Trah Vinh Province. Two of the technicians I had trained from the province, Miss Hain, Mme. Sam (head of the VWU for the district), Mr. Ngyan (my interpreter), and I loaded equipment from the van that brought us from HCMC into a small boat and headed down the Mekong River for a four-hour journey to Long Hoa.

We arrived at the commune, around 4:00 pm. The tide was high and so we had no problem getting the equipment close to the center of the commune and then off the boat into a storage shed. Long Hoa is on an island in Trah Vinh Province and there were no motorized vehicles of any kind. All transportation between homes was by boat or by foot.

Work started the next morning. The first homes were close to the center of the commune and the work went smoothly. Most of the houses were spread out and a boat was needed to go between them. Transportation of materials was the most time-consuming part of the project in this commune. The houses were far apart, and there were many “monkey bridges” to cross. These are literally branches across the water. I had enough trouble just crossing the bridges without carrying equipment, but the technicians had no trouble, even carrying large boxes and batteries. I was impressed.

The technicians learned fast and worked quickly. The technicians from both Long Hoa and Hoa Minh worked together, and this was an optimum situation. The systems were easy to install and there were too many people to put in one system at a time. After the first few installations the technicians split up into two groups. This was their idea and the work went much more quickly. I tried as best as I could to monitor all installations, but some were quite far away and this was not possible. I talked with the technicians about problems and communicated clearly what I wanted done and how it should look.

Since there was no material included in the Uni-Kit to hang the lights, we used heavy wire that we shaped into a hanger. The technicians got quite good at this and came up with some interesting and innovative designs. We were limited by the length of the cord provided with the Uni-Kit for the placement of the panel and the lights. I tried to stress the fact that we wanted the installation to be long lasting but also aesthetically pleasing. Under the circumstances, they did a great job. Solarlab provided us with hangers for the wire. These were small, made out of plastic and breakable. There were some hangers provided with the kits but no small nails, or nails with big heads, which made using these hangers difficult.

We worked long hours, starting early each morning and coming back the first two days after dark. The second day proved to be more interesting. We started early again around 7:00 am. This time we had to go by boat to the first installation. In the morning the tide was extremely low and we had to carry the equipment through about 100 meters of ankle to knee-deep mud. It was really just another time-consuming obstacle, but it provided some interesting photos!

The people of the community loved the PV systems. Most households had televisions, and some had both televisions and tape decks. The tape players were mostly 9-volt and incompatible with the 12-volt system. I was able later to rectify this problem, but not until I got to the second province.

Solarlab provided a small board with two external switches and a receptacle. The receptacle was for standard AC. The problem with using this was that with DC polarity has to be observed. The technicians had to mark each receptacle with the correct polarity. Whenever possible, the TV or cassette player was hooked up permanently. We did not have any AC plugs to provide for the appliances, and this type of setup was not used again.

Each homeowner was responsible for providing a wooden pole. A majority of the sites had excellent solar access and no problems with shading. Some of the sites, however, were completely shaded. I had to tell at

least two families that we couldn't install the system unless they agreed to cut down some trees. Fortunately, they agreed. This type of problem could have been eliminated, and should be watched for in the future.

After the first night, we were able to eat dinner under solar-powered lights. On the first day the technicians installed six systems, on the next day twelve, and on the last day seven. We finished early on the third day and returned to Trah Vinh town for a rest.

After one day in Trah Vinh town and delivery of the equipment from HCMC for the second commune, the entourage headed to Hoa Minh. This commune was about an hour closer by boat to Trah Vinh town and was visibly more wealthy. There was a definite center of town with a central marketplace. Homes were closer together and there were carts and bicycles on the paths. The commune also had a large Catholic church. I was surprised to see such a large church in such a remote place, but I guess the missionaries over the years did their jobs well. I was told that approximately seven percent of Vietnamese are Catholic.

Above: Poster from VWU promoting the project Solar Electricity and Light for Women and Children.

After the first commune was completed, Mme. Sam had to return to Hanoi. The project went smoother when she was around, because she spoke some English and understood the logistics and the politics of the system and the people. She also sat through my training sessions and had a good idea of how the systems worked. She was able to alleviate many problems and people's fears when she was available to answer questions. The interpreter was enthusiastic about solar. He worked alongside the technicians and learned as much as possible as fast as possible. This was helpful, but he had no prior knowledge of any type of solar and I am not sure he fully understood what he was told, so I don't know if he always translated my questions correctly.

The second twenty-five systems were installed in two days. There were more instances of shaded locations, but we shortened the poles and instead of planting them we attached them to the middle of the houses in positions where the panels could be out of the shade. This type of installation was more difficult. It involved a lot of climbing walls and modifying a bit of the house construction, but everyone chipped in and helped.

In Hoa Minh many of the systems were installed in the central market area. This posed a new problem. We had one or two instances in the first commune where the ballast from the lights interfered with the television. This meant that the lights and the TV could not be on at the same time, which would have been all right if this were the situation in each home, but it wasn't. People want what their neighbors have and if the situation is different


Above: PV transport by cycle in downtown Ho Chi Minh City.


Above: Transporting equipment between rice patties.


Above: Marlene donning the local attire.


Above: The happy baby with solar.

from theirs they will let you know. In Hoa Minh, since the houses were so small and were separated only by a bamboo wall, the ballasts from the lights of one house would interfere with the television of the neighboring house. This did not go over well, but I hope all parties were civil! It was explained to me by the folks at Solarlab that the interference is due to the lights and the televisions operating at close to the same frequency. Solarlab also encountered this problem, and found that when they use lights at a frequency different than that of the television the problem is eliminated.

In Hoa Minh, Solarlab provided a board that had two switches only. The television was supposed to be a permanent installation. This became a problem because the system had to be installed using the wire provided. Sometimes the placement of the television was not in an optimum location for the system. The technicians came up with the idea of attaching the plug that had been cut off from the external switches to the end of the cord for the television so that it could be plugged and unplugged easily from the system. This proved to be a good solution. By using this plug the user would not have to worry about polarity because the plug attaches to the controller only one way.

Tien Giang Province—Phu Dong and Phu Tan Communes

Just after Tet (Chinese New Year), the biggest holiday in Asia, I met with Solarlab and we discussed the next part of the project. In the following days, I spent much time in various markets acquiring tools and materials for the second set of communes. For these two communes I wanted to hang the lights from some sort of chain. Mr. Dung (pronounced Zung!) helped me negotiate the purchase of 50 meters of chain from an animal market, and some diodes. The purchase of the rest of the equipment—flashlights, electrical tape, screwdrivers, wire and nails—I negotiated with my new knowledge of a few Vietnamese phrases and numbers. I also spent some hours soldering diodes at Solarlab to help fix the problem of using a 9 Volt cassette player on a 12 Volt system. Since each diode has a 0.7 Volt voltage drop, putting three diodes in series helped reduce the voltage from 12 Volts to under 10 Volts.

Mme. Sam flew down from Hanoi on Feb. 8th, and we left for Phu Dong the next day. Mytho is the capital of Tien Giang Province and we arrived there in about three hours. We met with Miss Mai, and after lunch Mme. Sam, Miss Mai, Mme. Sung, Mr. Knip, Mr. Thong (my interpreter), various other people connected with the VWU, and I, set out for Phu Dong. We drove for about 45 minutes by car to a boat where we loaded equipment.

The boat was run by the Vietnam Coast Guard. The whole situation was interesting to watch. The military men would not work or help until their commanding officer made them. Once they did cooperate, everything was loaded quickly. It took us quite a while to reach Phu Dong because the tide was going down. Once we reached the commune I was met by most of the technicians I had trained, and also by about 100 children. (In the Mekong Delta I felt like the Pied Piper with many children following me everywhere.) I discussed with the technicians how we would do the installations, and other logistics. The party leader was also present because we learned from the first commune that this person wields great influence and if he is around things go much smoother. I told him I wanted someone to help keep the children from coming too close and being in danger. He told me a policeman would be provided.

The next day we began the installations. I demonstrated how to install the first system. They took me to a centrally located, extremely small house and it was hard for everyone to watch. The policeman kept leaving and taking cigarette breaks somewhere else and was generally not much help. It was difficult to get some of the technicians to work and even though my translator was quite good, he didn't know anything about solar and I wasn't sure what he was communicating was accurate. Mme. Sam told me she had to correct him many times because he did not translate what I asked. Even with all these setbacks, we installed five systems on the first day.

The next day fifteen systems were installed. Again, both Phu Dong and Phu Tan communes were represented and we split into two groups. Mme. Sam went to every single house with Mme. Sung before the technicians arrived, to reiterate the purpose of the project and explain exactly what the Uni-Kit consisted of. Later, I found out from Solarlab that the party leader coordinated most of the project within the commune, including lining up the families. The leader of the VWU in this commune was new to the job and not well organized, but the people were receptive to the project and seemed pleased with the systems.

We traveled to Phu Tan, the last commune, mostly by car and motorbike. The people there make their living shrimp farming. We stayed at the Coast Guard headquarters, and there were absolutely no facilities and no clean water—also the head of the VWU in Phu Tan was quite young and not well organized. The houses were far apart and there was much shuttling on the motorbike and lots of walking. However, the first day of work went fine. We split up into two groups and fifteen systems were installed in the first day. Altogether

twenty-five systems were installed. Mme. Sam was recalled to Hanoi and did not stay with the project through this commune.

The next day I took a motorbike back to Phu Dong. It proved to be quite close and the road was fine. I met with Solarlab and worked with them for the rest of the day. I moved back to this commune for the night. That afternoon the 500 Wp community center system in Phu Dong was completed and one of two street lights, purchased by SELF from Solar Outdoor Lighting in Florida, was set up that evening in the marketplace. In most rural areas the market closes early, but in Phu Dong the market stays open till at least 9:00 pm every night, so the commune was a perfect candidate for the 75 Wp solar street light.

Problems

Some problems could have been eliminated beforehand, but many were solved along the way and will serve as learning tools for the future. In general, the problems were minimal compared to the overall successes. One problem I see is that the technicians have so far only been trained on one type of solar lighting kit, and may have difficulty if they work with other systems. However, the technicians did catch on easily and most tried hard to learn as much as possible in a limited amount of time.

A knowledge of electrical practices in Vietnam would have been helpful before the beginning of the project so that materials and tools would have been better stocked. I had to work with whatever tools and equipment were available. In fact, the only tools on hand for the project were those SELF and I had shipped. More spare parts should have been included with the original shipment. The lack of these made for many problems and worries that could have been avoided, but more were sent afterward.

Because most people were quite curious, especially the children, it was difficult to work. I am trained as an electrician and have had the concept of safety redundantly reinforced, so I found it difficult to have so many children around so close to live electricity. I stressed over and over the dangers that were present and the need to keep the children away. The concept was never understood, not one child was ever moved, and many people thought that I just didn't like children!

I tried to make every situation as safe as possible, but many times I just had to close my eyes to safety. I tried to get the technicians and any others that were helping to use a ladder, but often a person would get on top of a stool which would be put on a chair which was put on top of a table or two. We rewired some televisions that were wired with antenna wire and wrapped in cloth, an electrical nightmare. (I never saw electrical tape in the field, only connections that were twisted. If the connection was wrapped, it was always in cloth.) It is hard to stress safety when there is no way to implement it. The Vietnamese use what they have readily available and make it work. I guess they learned a lot about resourcefulness during their long war for independence, followed by the "American war".

Conclusion

This project is still in the pilot phase, and much has already been learned which will be useful for the future. The Vietnamese people are warm and open and excited about solar. I was the first foreigner many of them had ever seen and in most places the first foreigner they have seen in twenty five years. They couldn't thank me enough for bringing light to their homes.

Solarlab was a godsend. These folks work quickly, are efficient and easy to

Above: Mounting the panel on a thatched roof, Hoa Minh Commune.

Above: The community center system, Phu Dong Commune.

Above: Successful graduates of SELF's training, Ho Chi Minh City

Above: Setting up a streetlight, Phu Dong Commune.

work with, and I enjoyed working with them. Without them the work would not have been as well done.

The VWU is a strong and well-represented organization, and can reach areas of the countryside that would not be accessible in other instances. They are excited about continuing and expanding the project, and the mechanisms are in place for its continuation. I feel privileged to have been part of this project.

Access

Author: Marlene Brown, 207 Cornell SE Apt D, Albuquerque, NM 87106. E-mail marlene@unm.edu. Besides rollerblading and African dancing, Marlene is working toward her graduate degree in Electrical Engineering, working at Sandia National Lab in the PV division, and teaching classes in RE through the University of New Mexico's Continuing Education Program. Marlene is still working for SELF and hopes to work on another project in the near future. She will soon have her Journeyman Electrician's License.

Solar Electric Light Fund (SELF), Neville Williams (President), 1734 20th St. NW, Washington, DC 20009 • 202-234-7265 • FAX 202-328-9512 • E-mail solarlectric@lcg.org

ANANDA POWER TECH

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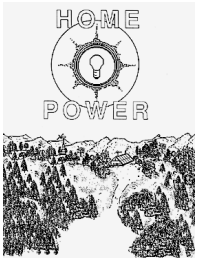
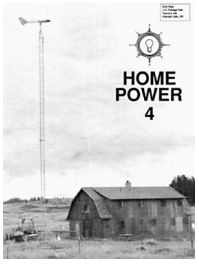
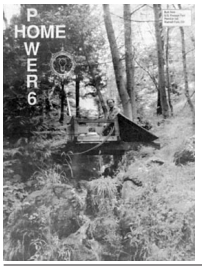






Then and Now—Fifty *Home Power* Issues

Richard Perez

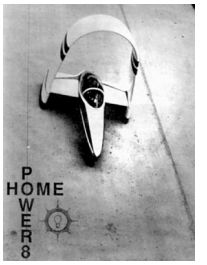
We mailed the first issue of *Home Power* in November 1987. Over the last eight years we have published 50 issues of *Home Power*. Renewable energy has changed over this seemingly short period of time. Eight years ago, powering one's home with renewable energy was considered a fantasy. Now RE-powered homes are becoming commonplace. What happened? Why did things change so quickly?

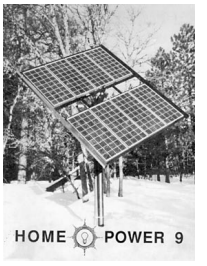
Pioneers

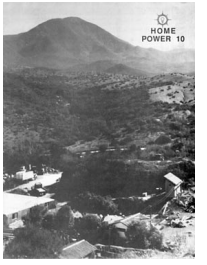
The first home-sized RE systems were installed by the back-to-the-landers during the 1970s. During this time an RE system was less expensive than five miles of newly installed utility power line. In those days RE was very expensive and the utilities were charging less for line extensions into rural areas. The common home power scenario we all joked about was, "Two hippies in a tepee." And this joke came closer to the heart of RE than most realized. From 1970 to 1990 many pioneers fled the cities in search of a better life in sparsely populated rural areas. We all discovered the same basic truths about buying rural land. If we could afford it, then the land had no utility power access, no telephone access and probably bad or no road access. We didn't care and thousands of us moved to the country anyway.

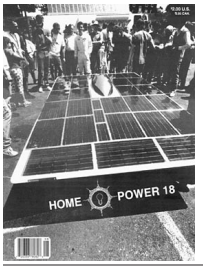
Many of us were content with kerosene lights or candles. We hauled our water in buckets. Our only electrical luxuries were disposable batteries for a flashlight, radio or cassette tape player. After years of this, many of us decided to go electric with small 12 VDC battery systems. The battery was usually recharged from a gasoline-fueled, engine generator that also did big jobs such as pumping water. During the early 1970s, NASA was just about the only one who could afford space age marvels like photovoltaic modules.

In 1985, the very first efficient and reliable inverters hit the market.









They instantly revolutionized home power systems—reducing generator operating time and allowing constant access to many conventional 120 vac appliances. Most early systems were strictly 12 VDC. If the appliance didn't come with an automotive cigar lighter plug, then we weren't interested. I am reminded of Karen's first blender. It was a 12 Volt DC model which consumed a whopping 15 Amps. It required heavy power wires and a socket installed in the kitchen. The blender had two speeds (on and off) and cost over $80 through a mail order catalog. Compare this with the standard department store blender available everywhere—12 speeds and a cost of less than $30. The situation was similar with most appliances—the low voltage DC models were more expensive, with less features and less power. Add the complexity and expense involved with wiring a home for efficient 12 VDC power use, and it's easy to see why inverters became very popular very quickly.

As we began the 1990s, the price of PVs, wind turbines and microhydros dropped. Not only was the hardware less expensive, but we also had many choices of size, type and brand. Most of the early pioneers were ready to kiss their generators goodbye. Anyone who has run an engine generator as a prime power source for years knows what is involved. Sustained engine operation is a nightmare of maintenance, expense, pollution and noise. We were ready to switch to renewable energy sources and these RE technologies were just becoming affordable and cost-effective. By the beginning of 90s, an independent RE system cost less than one mile of newly installed utility power line. As we enter 1996, a home-sized RE system costs less than 1/4 mile of new power line and is far cheaper than running a generator.

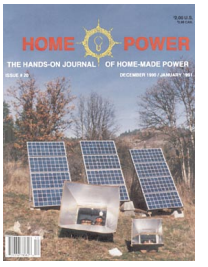
Along with the better, less expensive RE hardware has come heightened public awareness of what renewable energy sources can accomplish. I'd like to think that we at *Home Power* have helped spread the word about renewables. You don't have to be a Rocket Scientist or Daddy Warbucks to have a home which is independently powered by sunshine, the wind or falling water. All we need is a little technical information about how the systems work and access to competitively priced equipment and services. Let's look at each RE technology and see what we can expect in 1996.

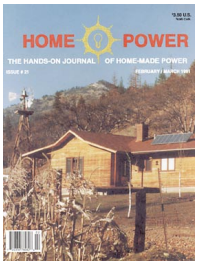
Photovoltaics

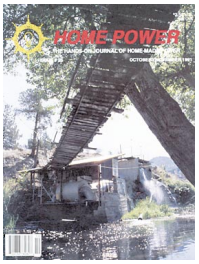
Look for continued small cost decreases for photovoltaics. Every PV maker I know is expanding—at least three new PV manufacturing plants are going to come on line during 1996. I know of two major PV makers that sold their entire 1995 production by August of this year. PV warranties to the enduser will continue to increase—we've already seen an increase from ten years to limited warranties as long as twenty years. Along with less cost, we will also see increased performance from photovoltaics. Module efficiencies are reaching the 18% range in single crystal PVs and entering the low 8% regions for amorphous PV. There is a distinct possibility that 1996 will debut PV roofing. Two makers of flexible solar electric roll roofing expect to be to market in 1996.

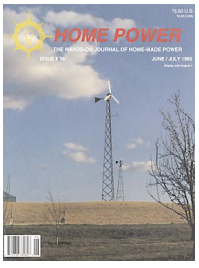
Wind

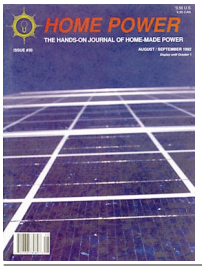
The big news in wind generators is small affordable "starter" turbines. Many systems that are











primarily PV-sourced are replacing their backup generator with a wind turbine. We now have a choice of seven different turbines in the 1 kW and under class. These turbines will find their way into many RE systems during the next year. All wind generators will benefit from modern, hi-tech materials like carbon composites, stainless steels, and durable plastics. We will continue to need better, simpler and more affordable towers for these small machines.

MicroHydro

Small hydro turbines will continue to evolve. New, more efficient runners are being tested and implemented. New techniques for higher voltage operation will allow these turbines to be located further from the battery or point of power use. We already have turbines that will work on heads of less than 10 feet. I know of one system in our neighborhood that has a head of 25 feet and a flow of 12 gallons per minute—this adds up to over 4,000 Watt-hours per day.

Inverters

The big news in inverters is sine waves. For most systems, sine wave inverters offer greater performance at only slightly higher prices and slightly lower efficiencies. Look for the introduction of two new sine wave inverters during 1996. Some of these new inverters will be capable of utility intertied operation—they can sell RE to the utility. These utility compatible inverters are moving renewable energy onto the grid. Recent legislation in California and existing legislation in other states is giving the small scale RE producer a better price for their power.

Controls

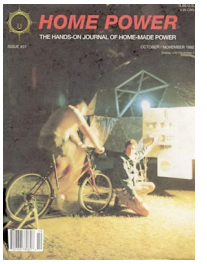
Controls and power processing electronics will continue to get smarter and more powerful. Of particular note are the DC/DC converters. The next generation of these devices will enable us to place our power sources (solar, wind or hydro) further from our homes. Next year will see many controls being UL or ETL listed. Many systems are going on grid and in areas that require NEC compliance for all the hardware—controls and power processing electronics are no exception.

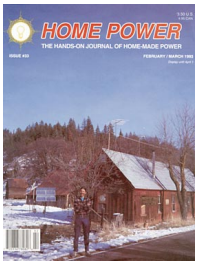
Power Centers

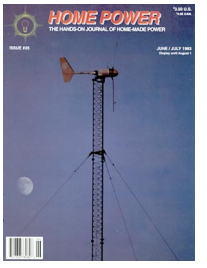
Power centers are allowing systems to be more compact, NEC compliant, and easier to install. Currently I know of at least four companies making power centers and I expect several more to spring up in the next year. If you are installing your own system, a power center can make it simpler, safer, and instantly palatable to the electrical inspector. The main advantage of using a power center is standardization. In the next year I expect to see less wall space dedicated to “conduit and little boxes”.

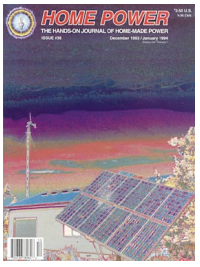
Batteries

The next year promises better batteries in more varieties. Nickel-iron batteries are once again becoming available. The electric vehicle industry is developing higher efficiency and more rugged lead-acid batteries. New technologies like Nickel-Metal-Hydride will come closer to being marketable products. After years of only small changes, the battery industry is now moving ahead with newer technologies. Although most of this rush of innovation is prompted by electric vehicles, RE systems will also benefit from better energy storage.









Appliances

Every dollar spent on efficient appliances will save three dollars in RE hardware. The importance of using efficient appliances will not decrease next year. Fortunately, the electrical appliance industry is making major strides in efficiency. Look for better, longer lasting, less expensive compact fluorescent lighting, refrigerators, and electronics. The companies that make mass-marketed appliances are being made more aware that the efficiency of their appliance is important to the consumer. Do your bit, on grid or off, by purchasing the most efficient appliances you can find.

Where are all the HP Cover Stories Today?

I started checking up with the folks who made up our early cover stories. I wondered how they were doing, were they still using RE, and had they changed their systems.

I was amazed at the diversity of response. Some systems had changed hands twice. Each time the property sold, the renewable energy system had actually appreciated in value. Not only are these systems making it easier to sell your homestead, but you'll make money on the system when you sell it along with your homestead.

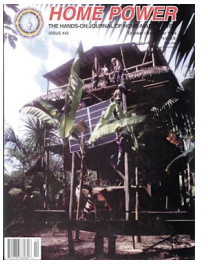
Many of our cover people are still living on RE at their homestead. Almost all of the systems have grown, with the most common additions being more photovoltaic modules, newer inverters, instruments and wind generators. For example, our cover story in *Home Power* #13, Jim and Laura Flett had two children. Jim increased the number of PV modules from eight to twelve to accommodate the new kids. Growing families are easily satisfied with RE systems.

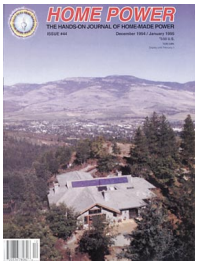
In some cases the initial system was so well designed and installed that no changes have been made for six years or more. For example, Victor and Cynthia Rubio's system (cover of *Home Power* #10) has received no attention other than watering the batteries since it was installed in February of 1989.

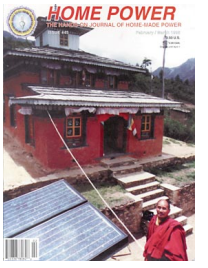
The Future of RE

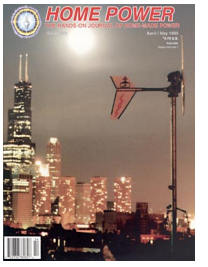
Small scale RE systems are well on the way to eliminating expensive power line extensions. RE systems have already displaced the engine generator as the prime source of power in remote rural areas. Renewable energy has already won the battle off grid. RE won by being less expensive, less hassle, and better for us and our planet.

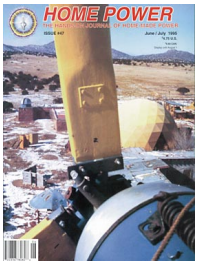
The next frontier is "on grid." The challenge for the rest of this century is to place the electricity made worldwide by small scale RE systems onto the grid. Technology has made obsolete the power production monopoly held by the utilities for the last century . We now have a better way to meet this planet's electrical power demands. Each individual can own their system and sell their surplus power back to their local utility. Since the bulk of this distributed energy will be solar, power production will coincide with peak power usage. Distributed production will lessen the loading of long distance power lines and eliminate the necessity of constructing new and bigger power lines. Using renewable resources will vastly reduce the pollution associated with nuclear and fossil-fueled power plants. As well, those selling their RE power to the grid will develop the financial security of independent power and maybe even get a second source of income from energy farming.

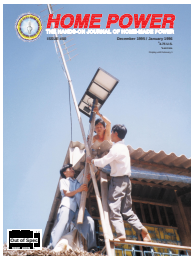












I'm looking forward to publishing *Home Power* on into the next century.

If independent RE systems have come this far in only eight years, the future is going to indeed be bright. I salute each and every one who has made renewable energies part of their lives. You are energy pioneers lighting the way to a better future.

Access

Author: Richard Perez, c/o *Home Power*, PO Box 520, Ashland, OR 97520 • 916-475-3179 • E-Mail: richard.perez@homepower.org

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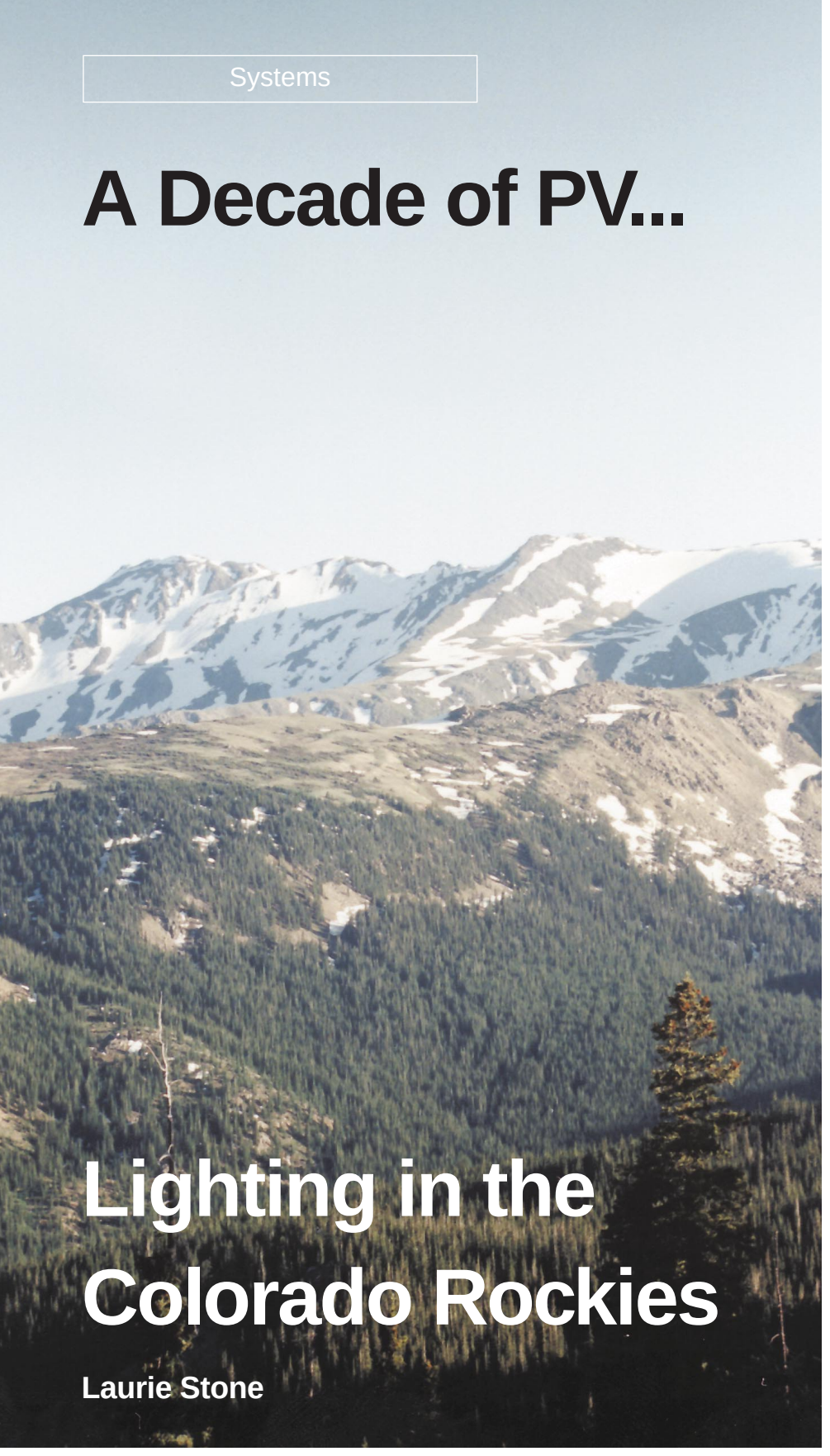
A Decade of PV...



Lighting in the Colorado Rockies

Laurie Stone

Above: The Tenth Mountain Division Hut Association's network of twenty two high mountain lodges offer breathtaking views of the Colorado Rockies like this one of Mt. Massive (14,421 feet) as seen from the Skinner Hut.

Backcountry skiing in the Colorado Rockies is exhilarating and exhausting.There's nothing better after a hard day of skiing through fresh powder than ending up at a mountain hut miles from the nearest town with a wood burning stove, comfortable beds and solar-powered lights.

This might sound like a dream too good to be true. Yet in the mountains between Aspen and Vail there is a system of ski huts called the Tenth Mountain Division Hut Association (TMDHA). The "huts" are actually beautiful mountain lodges with everything you need for a pleasant relaxing night, including PV-powered lights.

The name "10th Mountain" honors the soldiers of the 10th Mountain Division of the US Army. Fifty years ago, at the brink of World War II, the U.S. War Department realized it was necessary to train mountain troops. The troops trained for two years in the Colorado Rockies. By 1945 they were in Italy where they had a crucial role in several battles.

Thanks to these troops, and to some dedicated Colorado skiers, we can say goodbye to the days of cold, winter camping and hauling lots of gear. We now get in all the Telemark turns we want and have a nice warm place to drink a glass of wine at night. There are twenty-two huts in all. Thirteen of them form a loop between Aspen and Vail. The other nine are located south of Aspen and are called the Alfred A. Braun Huts and the Friends Hut.

Why Solar?

TMDHA is a non-profit corporation, formed in the early 1980s, that manages the huts, which are linked together via intermediate ski touring trails. Each hut sleeps from 16 to 20 people, and anyone can make a reservation for the night.

One of the dilemmas from the very beginning was lighting the huts. At the time, TMDHA was spending $500 a year on fuel for each minimally lit hut. PV-powered lights seemed perfect for the remote cabins. Three professors from the local Colorado Mountain College (CMC) who were teaching classes on solar energy, set out to convince the TMDHA staff that solar was the way to go. That did not prove to be an easy task. The TMDHA Board was interested, but, as with any new technology, there were some reservations and many questions.

One of TMDHA's big considerations was aesthetics. The huts are located in beautiful, pristine mountain settings. Some felt that backcountry skiers would regard the solar electric panels as detracting from the beauty and the rustic feeling of a high country experience. However, there were safety issues to consider. They were presently using volatile fuels for lanterns, along with a large number of candles. The first hut in the Braun Hut system, the Lindley Hut, burned to the ground because of a careless candle user. Environmental considerations also abounded. Hundreds of lantern sized propane tanks were becoming a disposal problem. Safety and the environment won out. The TMDHA staff decided to make a commitment to solar.

Left: The old Kerosene lanterns were replaced with DC compact fluorescents retrofitted into rustic antique style fixtures.

Joe Schwartz, an SEI student, wires the replacement panels for pole mounting at Uncle Bud's Hut.

Requirements and More Requirements

Designing the systems was another story. The huts all experience extreme winter conditions. They are all over 8,000 feet in elevation where the temperature can get as low as 40F below zero. The users of the systems are people who are not trained or knowledgeable about solar electricity. Approximately 21,000 people use the huts each year, usually spending only one or two nights at each hut. Some of them would probably not realize they are using solar powered lighting, or even know what photovoltaics are! So the systems had to be reliable.

Although the solar design advocates didn't want to inconvenience people, they did want to educate them about living with solar. The list of requirements for the systems was getting longer by the minute. Taking everything into account, for the PV systems to be effective, they needed to be reliable, understandable, manageable, educational, convenient, simple, sustainable, and low cost. Not an easy list to fulfill.

Nevertheless, when the systems were first installed in the early eighties, the CMC instructors assembled all of the basic components with these considerations in mind. To keep the systems as simple as possible, they were all 12 Volt DC systems. Inverters were not as dependable then, and reliability was crucial.

We learned a lot of lessons trying to meet all the concerns. However, the growth of the PV industry and

Above: Johnny Weiss and the SEI introductory PV class pose for a “System Completed” photo with the new year-round array at Uncle Bud’s Hut.

the evolution of the components, have allowed the systems to be upgraded to answer many of these concerns. The CMC instructors went on to found Solar Energy International (SEI), a non-profit educational organization. SEI, Rocky Mountain Solar Electric, and

Above: The Traditional style of Uncle Bud’s Hut integrates perfectly with the natural beauty of the Rocky Mountains. Notice the winter oriented (vertical) array before its replacement with an all-season pole mount system.

SunSense Solar Electric Systems, local PV installers and dealers, have installed systems on all 22 huts that are safe, reliable, understandable, economical, and, most important of all, work well.

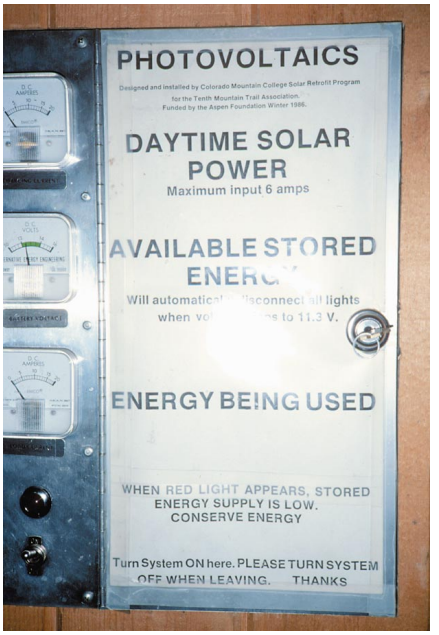
An Array of Arrays

We can happily say there have been no module failures over the past decade and a half. The huts all have different modules that are being used in extreme winter conditions. The cold, wind, hail, ice and snow has not posed a problem for a single panel. The systems range from one to six panels, and we have not heard a single complaint about the panels being an eyesore. No one has ever griped about their wilderness experience being marred by high technology. And the huts have seen a lot of hard core back country environmental folk who want a true back country experience.

The huts originally had US Forest Service permits for winter use only. This allowed us to mount the panels vertically on a south wall. The snow reflection and the low winter sun provided a lot of power from the panels. However, now the huts are also being used in the summer. Even though the summer provides us with more and longer sunny days, many systems are not providing enough power because of the higher summer sun angle. Therefore, nearly all of the systems are being retrofitted.

Controls for the Unknowing

If there was one lesson we learned, it is that you can never make a system simple enough for all of the people all of the time. Two main considerations were a



Right: Analog meters and layman's instructions make for a simple and easy to operate PV system.

Left: Ananda Power Centers offer expandibility in an easy-to-use package. Note the fire extinguisher and emergency flashlight.

low voltage disconnect (LVD) and a low voltage warning light. A LVD protects the batteries from over discharge. An low voltage warning light forewarns hut users of the impending loss of light, hopefully causing them to be more conservative in their use of the lights. Since we're not able to educate every single skier who is going to stay overnight at the huts, these two components are crucial.

Originally the control/meter package had to be specified and built out of individual components. While this was a great educational opportunity for us (since all but a few of the systems have been installed by our students in PV workshops), it was quite time consuming. Now we use an Ananda Power Center for all the controlling and metering. It gives us many more capabilities than we will ever need for the small systems (for now, at least). TMDHA likes the Power Center too, because it's attractive, UL approved, very expandable and a good step toward our efforts at standardization.

The original package had three analog meters; battery voltage, array current and load current, all clearly labeled and explained. Analog meters were chosen because flashing digital lights in a remote mountain setting seemed slightly obnoxious. In the early systems, we used an automotive fused DC load center and, for a short time, an automotive light as a warning light. However, we learned the light would go on during LVD, stay on, and drain just enough energy to prevent the battery from being recharged. We quickly changed to less consumptive LED warning lights.

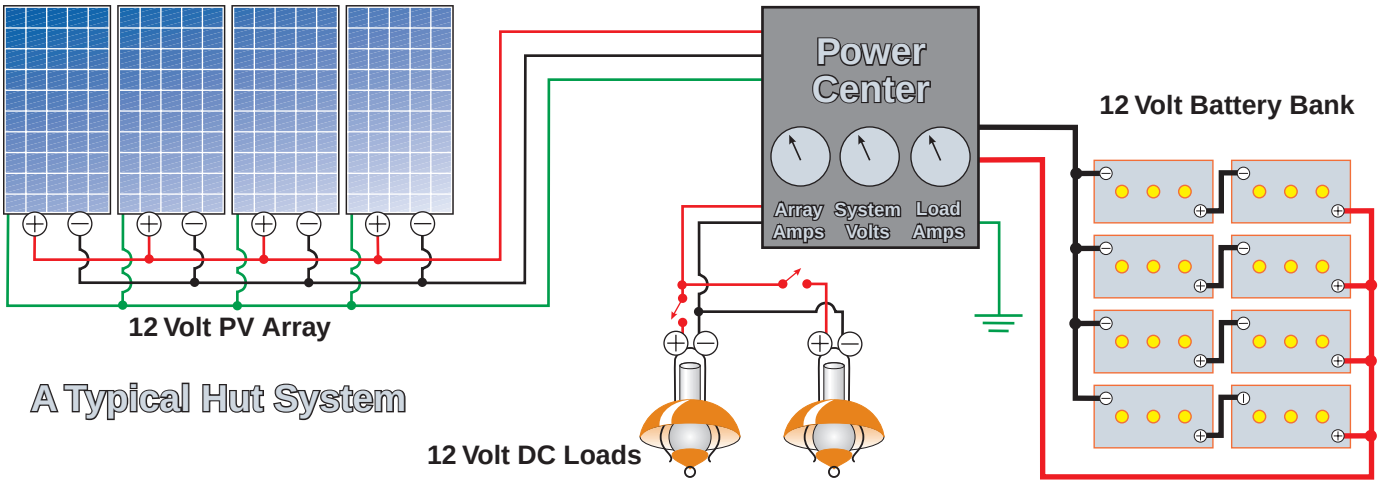
Inside the control boxes we use a variety of factory and field-adjustable controllers, most with temperature compensation. These have all proven reliable throughout the years. Ananda Power Technologies has been helpful in customizing the Power Centers for us. The original Power Centers have labels and meters that the average hut user does not need to understand. We have simplified the center and stayed with the analog meters so that the controls will be understandable to everyone and familiar to past users.

Storage for Snowstorms

Batteries provided us with yet another challenge. The huts get the heaviest use during periods of least sun and when the batteries are the coldest. This is an inherent mismatch, but not an impossible situation. The battery pack just needed to be sized effectively for the conditions. Most of the systems use lead acid batteries, although there are two systems with nickel cadmiums and nickel irons.

There was also no back-up source for battery charging, except for the occasional very inconvenient generator/battery charger. It is quite doubtful that several systems have ever been properly equalized. This led to the premature need to replace several battery systems. The "don't fix it 'til it's broke" rule doesn't work for batteries! Battery maintenance has

Right: Six Trojan T-105 batteries 660 Amp-hours at 12 Volt in the Gates Hut.



A Typical Hut System

been the responsibility of TMDHA personnel and has been irregular. Keeping the huts useable when tens of thousands of people use them each year is a huge job. The small TMDHA staff have many other things to do besides check batteries. Some huts went years without being checked. Some batteries have been boiled dry while others have been sulfated by insufficient charging. More sophisticated control strategies that allow us to conveniently equalize batteries will hopefully improve battery life.

Lights

The only load the huts have is lighting. Our desire to impress people with how well solar energy can light a cabin caused us to carry the lighting a little too far at first. A few of the remote mountain huts ended up looking somewhat like remote 7-11's. People could definitely see that solar energy worked! However, we eventually replaced the 22 Watt Circle Line fixtures and 13 Watt compact fluorescents with smaller compact fluorescents.

The main lighting consideration was to keep the rustic look. When TMDHA first heard we wanted to put in fluorescent lights they thought it was atrocious. We ended up retrofitting commercial ac, antique style lantern type, fixtures for compact fluorescents. This keeps the rustic look while providing an efficient lighting source.

One of the main questions over the years has been whether or not to change to an inverted 120 vac system. Although some of the 12 Volt DC ballasts have failed and are more expensive than 120 vac ballasts, TMDHA decided to stay with DC. Inverters, as reliable as they are these days, bring one more level of complexity to the system. However, many of the lights are being changed to incandescent 15 Watt DC bulbs to get rid of the ballast altogether.

Servicing the Systems

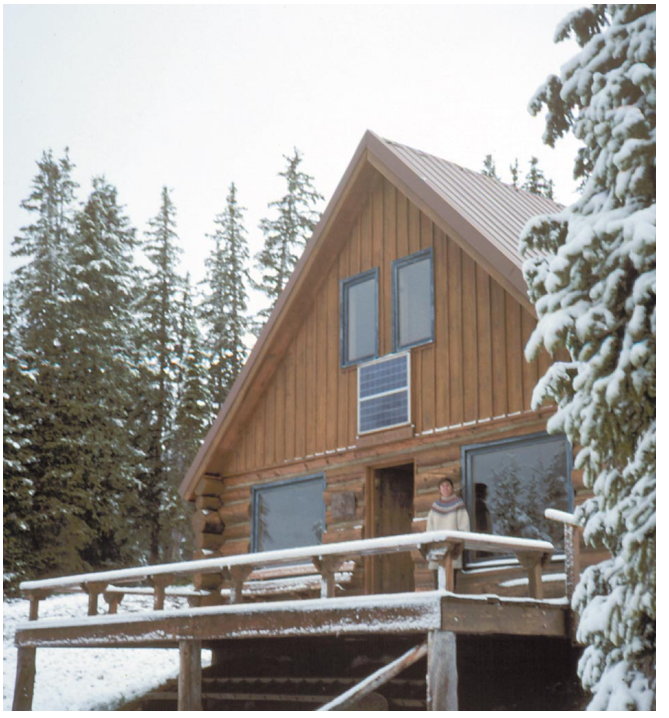
Monitoring the performance of the systems over a decade and a half has led TMDHA to the conclusion that they need a service contract. They are not solar technicians, or even homeowners who are living with the systems themselves. Although some of the TMDHA staff have been trained in PV maintenance, they have many other things to do. They now feel the solar lights are a valuable part of the hut experience. Now it is worth their while to have a maintenance/service contract to ensure top performance and high reliability.

SEI and SunSense are in the process of providing a maintenance and service contract for the hut's PV systems. It entails two trips a year to each hut to make sure the systems are working properly, tighten the

Above: Steve McCarney (former CMC Solar Professor) cooking up some dinner at the Estin Hut.

connections, and water and equalize the batteries. Not only does this guarantee that the systems are in top shape for the winter season, but it also allows SEI and SunSense staff to spend a couple nights in a beautiful remote setting in the Rocky Mountains.

The TMDHA hut systems have proven that PV systems can be made reliable and sustainable without constant monitoring. They have also educated tens of thousands of people about solar electricity. And they have made the back country experience of skiers from around the world safer, more environmentally benign, and a lot more comfortable.



Above: Skiing from hut to hut.

Above Right: SEI student Kerry Bell from Willits, CA solar cooking at the Skinner Hut.

Right: Author Laurie Stone enjoys a fresh snow at Margy's Hut.

Access

Author: Laurie Stone, Solar Energy International, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Internet e-mail: sei@solarenergy.org

Tenth Mountain Division Hut Association, 1280 Ute Avenue, Aspen, CO 81611 • 970-925-5775

SunSense Solar Electric Systems, PO Box 301, Carbondale, CO 81623 • 970-963-1420

Solar and Propane-Powered Home

Jeffrey R. Yago, P.E.

When most people think of an alternative energy home they think of a small cabin in the woods without modern conveniences. This solar home located in rural Virginia quickly dispels this myth as it includes a state-of-the-art automation control system, a whole house stereo system, a home video theater with six channel sound, whirlpool, and the most energy efficient appliances and lighting fixtures that are available today.

Home Design

The three story compact design consists of 3,000 square feet, plus an adjoining passive solar greenhouse, screened porch, and three level deck. The insulated, concrete slab ground floor with masonry walls is three feet below grade. This level includes the battery and control room, utility room, music room, home theater room, bathroom, and the greenhouse. The main floor has a double envelope exterior wall consisting of two 2x4 walls separated by 6" batt

insulation and finished with tongue and groove cedar. This level includes a cathedral ceiling living room, kitchen, guest bath, and two guest bedrooms.

The upper loft includes a large master bedroom, master bath, and a balcony study overlooking the living room. All windows are double-glazed, low "E" glass filled with argon gas. The skylights and solar blinds are motorized and can be remotely operated.

Heating System

The home has a 500 gallon underground propane tank serving high efficiency electronic ignition propane appliances. These include a six burner commercial stove, clothes dryer, propane fueled back-up generator, and a hot water heater which heats domestic hot water and supplies a space heating coil in the air handling unit.

Space heating is helped by a closed-loop water jacket in the wood burning fireplace which supplies a second heating coil in the central air handling unit. When space heat is required and the fireplace loop is not hot, the controls stop the fireplace loop pump and start the heating loop served from the domestic hot water tank. The greenhouse is heated by passive solar and requires no back-up heating.

The air handling unit fan distributes heated air throughout the house. Although this fan requires more energy to operate than a heating system using baseboard radiation, it was a design trade-off to move air from the cooler ground floor rooms to the warmer upper rooms. When the air handling unit was installed, the fan motor was discarded and replaced with a high efficiency motor. A freestanding Franklin style wood stove with an exposed flue is located in the high ceiling living room. This wood stove can also heat the house without additional fans or pumps.

Cooling System

The air handling system also has a cooling coil connected to an extremely efficient exterior air conditioner. The air conditioning system is wired to the utility breaker panel to avoid over-loading the generator or solar battery storage system. Due to the heavily insulated walls and windows, the air conditioner only needs to operate a few weeks each summer.

Since the home was located on a wooded hill of a lake-front development, natural cooling is provided by opening the lower basement windows and upper loft windows and skylights to create a natural draft. In addition, all three bedrooms include an efficient ceiling fan. Since all windows are located under large roof overhangs, almost all the windows are shaded during the summer months to reduce cooling requirements.

Generator System

Powering a home this size by photovoltaics alone would not be cost effective. To keep costs down, this home was designed to use propane gas for heating and hot water needs when the fireplace is not being used. On days we anticipate a large electrical demand, the seven kw propane-fueled generator is started to power the heavier loads including the clothes washer, clothes dryer motor, dishwasher, and whirlpool.

Any time the generator is operating, it is also used to power a battery charger to supplement solar charging. This method of control insures the generator is always operating at full load, and allows having the luxury of time-saving appliances without draining the batteries. By scheduling these periods of heavy loads during an evening and/or after several days of cloudy weather, the generator provides battery charging when needed most.

Circuits and Transfer Switching

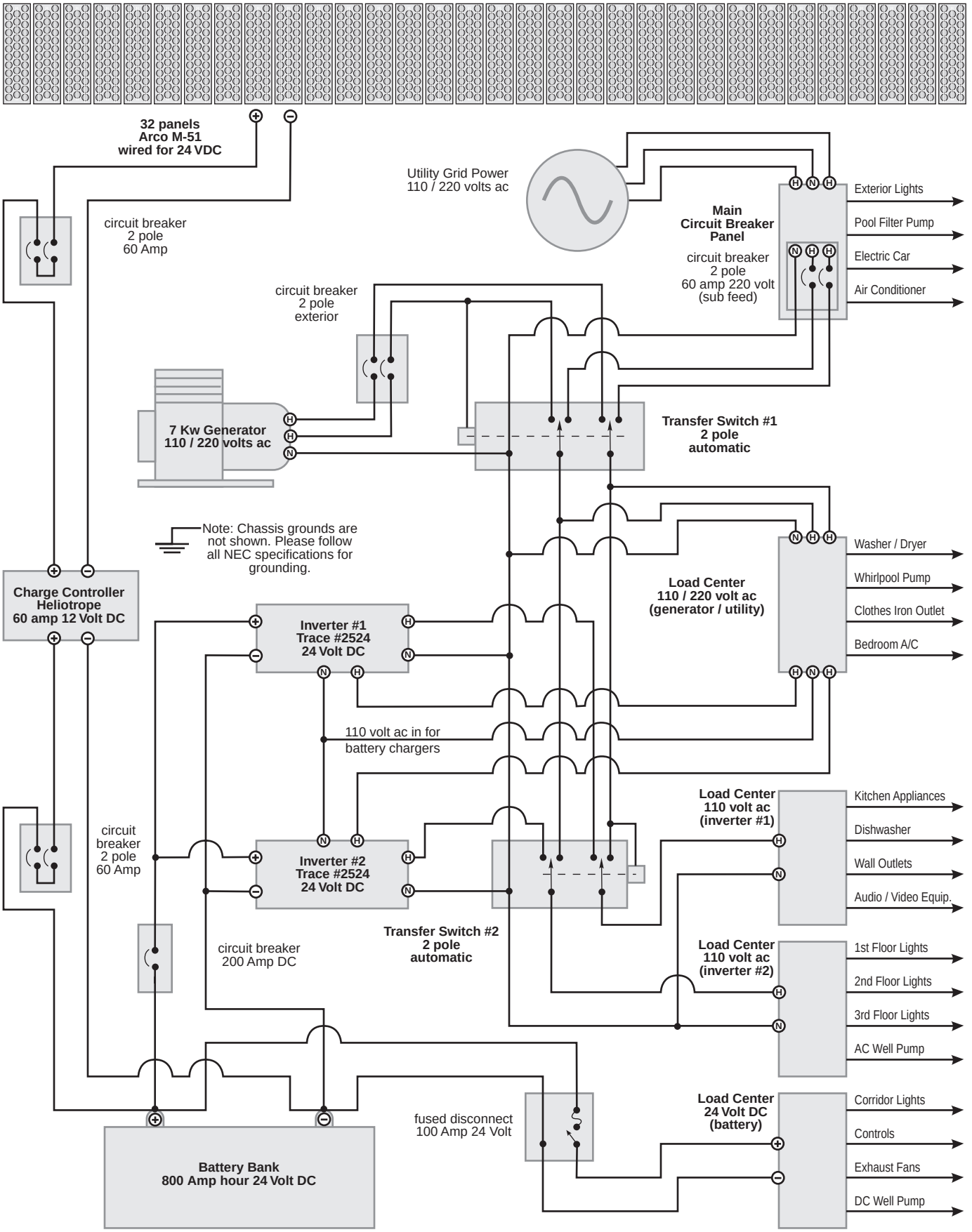
We wanted the power transfer between the inverters, generator, and utility to be as simple and reliable as possible. We designed a control cabinet with two double pole transfer relays and low energy LED panel lights to graphically illustrate the position of each relay.

Red LEDs are used to indicate all non-normal switch positions and green LEDs are used for normal position. Any lighted red LED on the panel indicates something has changed from normal operation and needs attention. The 110/220 volt main circuit panel at the utility feed has circuit breakers for the driveway lighting, pool filter, air conditioning unit, and a 60 amp-220 volt sub-feed to the first transfer switch. This switch transfers to the propane fueled 110/220 volt generator when it is started.

The first double pole transfer switch feeds the second transfer switch and a separate generator circuit breaker panel. This panel supplies all large appliance motors which can only operate when either the generator is operating or the main utility service breaker is manually switched on.

The second double pole transfer switch transfers both lines from the first transfer switch feed to two separate TRACE 2524 inverters anytime this feed has no power. The first inverter supplies the wall outlet circuit breaker panel which feeds most of the smaller kitchen appliances, audio/video equipment, and anything plugged into wall outlets.

The second inverter feeds all lighting circuits not wired for 24 Volt DC operation and the well pump. This second circuit reduced earlier problems with the loss of all lighting when the inverter was temporarily over-loaded by too many appliances operating at one time.


32 panels
Arco M-51
wired for 24 VDC
circuit breaker
2 pole
60 Amp
Utility Grid Power
110 / 220 volts ac
Main
Circuit Breaker
Panel
circuit breaker
2 pole
60 amp 220 volt
(sub feed)
Exterior Lights
Pool Filter Pump
Electric Car
Air Conditioner
circuit breaker
2 pole
exterior
7 Kw Generator
110 / 220 volts ac
Transfer Switch #1
2 pole
automatic
Note: Chassis grounds are
not shown. Please follow
all NEC specifications for
grounding.
Charge Controller
Heliotrope
60 amp 12 Volt DC
Inverter #1
Trace #2524
24 Volt DC
Load Center
110 / 220 volt ac
(generator / utility)
Washer / Dryer
Whirlpool Pump
Clothes Iron Outlet
Bedroom A/C
110 volt ac in for
battery chargers
circuit
breaker
2 pole
60 Amp
Inverter #2
Trace #2524
24 Volt DC
Load Center
110 volt ac
(inverter #1)
Kitchen Appliances
Dishwasher
Wall Outlets
Audio / Video Equip.
Transfer Switch #2
2 pole
automatic
circuit breaker
200 Amp DC
Load Center
110 volt ac
(inverter #2)
1st Floor Lights
2nd Floor Lights
3rd Floor Lights
AC Well Pump
fused disconnect
100 Amp 24 Volt
Load Center
24 Volt DC
(battery)
Corridor Lights
Controls
Exhaust Fans
DC Well Pump
Battery Bank
800 Amp hour 24 Volt DC

Although this switching can be manually controlled, all of the above operations are normally automated by relay logic without electronics.

Low Voltage Power

The 24 Volt DC breaker panel is supplied directly from the battery to the DC lighting and appliances without any further controls. These loads include all fluorescent corridor and stair lighting, the refrigerator, the freezer, a back-up 24 Volt DC well pump, and the exhaust fans in the greenhouse and attic. All fluorescent lighting fixtures powered by the system had their magnetic ballasts replaced with 24 Volt DC electronic ballasts.

The solar array is 32 ARCO M-51 solar panels with a seasonally adjustable mounting. The panels are wired in series-parallel to provide 24 Volts to the battery through a Heliotrope General 60 Amp charge controller.

Appliance Controls

Since RE homes have a fixed energy capacity, it was important to install high efficiency appliances and lighting. A computer system running programmed usage schedules and using room motion sensors operates the lighting, heating, and sound systems for each room. For convenience, everything can be manually controlled be entering codes from telephones located in every room or remotely when away.

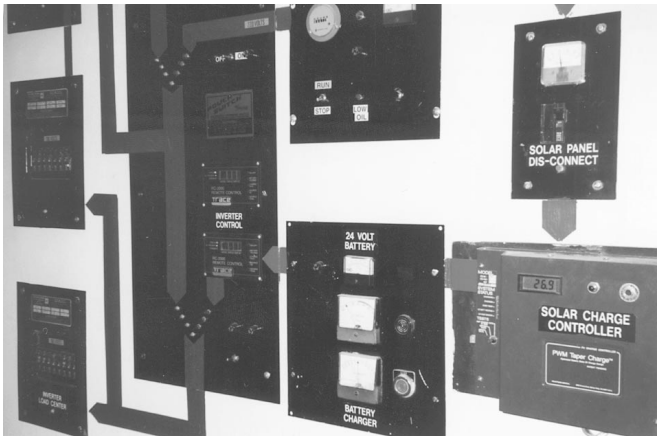
Lighting Design

In order to keep the number of solar panels to a minimum, we took great care with lighting design, which can use as much as 1/3 of a home's electrical demand. Each lighting fixture and lamp type was specifically selected for the intended location and use.

There are no conventional incandescent bulbs anywhere in this house. High ceiling areas requiring recessed lamps were fitted with low wattage halogen reflector bulbs. Almost all of the remaining lighting is 34 Watt fluorescent tube and 13 Watt compact fluorescent ceiling lights with electronic ballasts. The fluorescent lighting was selected in the 3000 to 3500K color temperature range to provide a warmer light than found with most cool white fluorescent lamps.

If every light fixture was operated at the same time, it would be less than 1/2 Watt per square foot. This is far below the typical 2 to 3 Watt per square foot of most homes and offices. Once this lighting and appliance electrical load was reduced to the minimum, it was then possible to design and size a more cost-effective solar system.

Although this home is connected to the utility grid for air conditioning and back-up needs, we are not affected by grid power outages which are more common and last longer with our rural electrical service. Only weeks after moving into this home, an ice storm left our county without electrical service for seven days. We were the only home with electricity. We provided many five gallon cans of water each day to area residents having wells with electric pumps. It may be possible to get by with flashlights and wood stoves, but it is very difficult to live without running water for drinking, bathing, cooking, cleaning, and flushing the toilet.



Above: Transfer Switch and Controls: The use of graphics and LED lights makes it easy to spot any electrical problems

Conclusions

We have lived in our home almost two years and have enjoyed the peace of mind knowing our home will take care of us, but I do not feel an alternative energy home is right for everyone. This style of living requires careful scheduling of energy usage, awareness of local weather conditions, daily checking on battery charge state, and periodic servicing of the batteries and generator. Most homeowners want the lights and television to operate when they turn the switch and do not care where the electricity comes from until it stops. We feel almost every home should include at least some of the features we have described to reduce energy usage and allow a family to remain comfortable through a power interruption. Today a power outage lasting over one day becomes a national disaster and can become life threatening for many. It does not need to be that way.

Award Winner

This solar home has won many awards including; first place in the 1992 and 1994 annual energy awards sponsored by the Virginia Division of Energy and the Virginia Propane Dealers Association respectively; and was one of nine finalists selected from all fifty states in

the energy awards competition sponsored by the National Propane Dealers Association at their 1995 convention in Dallas.

Access

Mr. Yago is a licensed professional engineer and president of J.R. Yago & Associates, a consulting engineering firm located near Richmond, Virginia. He has been involved in solar and energy reduction design since the early 1970's and has completed many projects in the United States and Europe. Phone 804-457-2113

SOLOPOWER
camera ready
black and white
7 wide
3.5 high

PV-Powered Communications

Stephen Bosbach

Six months ago we purchased a 1984 VW Westfalia camper van as vacation vehicle. My wife Crystal and I are both ham radio operators and lend a hand in the amateur radio Skywarn program of funnel cloud spotters. I thought it would also be nice to have a totally self contained communications van that could be used to operate radio gear indefinitely with enough sunshine! Weekend dry camps would also be a possibility with a little solar power. I also envision the van as a traveling educational tool to teach the simplicity and benefits of solar power. And there is that wonderful tilt up roof on the VW that could be pointed into a winter sun! I had taken a seminar on photovoltaic applications put on by the city of Austin and was eager to try a small PV project. I needed an excuse to get my feet wet in PVs and this was the best reason I could find!

We recently completed three weeks of vacation travel in this camper outfitted with two 45 Watt PV panels and the new Trace C-12 charge controller. During that time we always had enough power for all our needs. Two weeks prior to our trip we used the van for a weekend to operate in the amateur radio Field Day competition, an annual exercise to test the readiness of amateur operators to stay on the air and handle information without access to the grid. I figured this would be an excellent shake-down for the entire system and should indicate any weak spots. Using our high frequency and VHF transmitters at five watts output, we operated for

Above: “Sunflower,” a 1984 VW camper, shows off the PV array on its tilt up roof.

18 hours of the 23 hour contest and only pulled the main battery down 30 percent. This included using the water pump intermittently, using a fluorescent light for three hours, and running packet radio with a laptop computer and terminal node controller. During the competition when the sun was high and we only had one transmitter running, we actually had a net gain in charge! I love it!

Choosing the Batteries

In designing this system, I wanted enough power to provide an optimum charge rate to a 100 Ampere-hour battery (C/20 rate is 5 Amperes). This turned out to be just about what two 45 Watt panels in parallel could provide. Eventually, I decided to use two 100 Ampere-hour, gel cell batteries (Western Auto group 27 marine batteries). One for vehicle starting and operation and the other for coach loads and communications gear with the option of paralleling both batteries in a pinch. I chose to replace the vehicle starter battery with another gel cell so both batteries could be trickle charged when the vehicle is not used for extended periods. With two identical batteries in parallel, the problems associated with different battery types with different peak voltages and charge curves are avoided. This was a

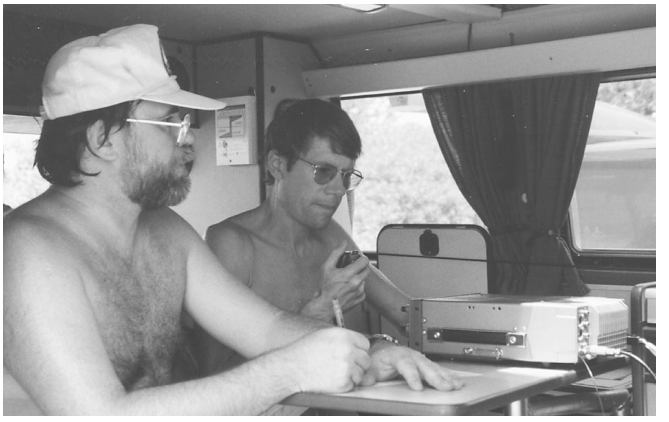
compromise with the charge rate when both batteries are charged off the solar panels, but this usually only happens when the vehicle is stored and the controller is just trickle charging. I also wanted the extra storage of a second deep cycle battery for the heavy draws of the refrigerator and high power radio transmitting.

This was an expensive decision, as gel cell batteries are not cheap, but they do have many advantages. They are perfect for RV use where the battery must be located in the interior of the coach. Gel cells are sealed and do not spill or outgas and can be positioned lying down and stacked. They are also more resistant to sulfation, do not need equalization, and have a slower rate of self-discharge. The safety factor of zero outgassing in an environment with an open flame from a gas stove was more than enough reason to spend the extra money on gel cells.

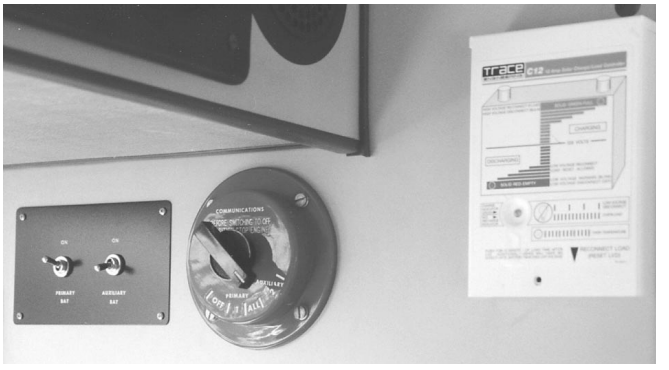
Controlling the Juice

Battery selection is controlled by switches that eliminate the need for a battery isolator and the 0.5 VDC drop an isolator consumes. This was a compromise in automation, so I have to remember to throw the switches manually. Using two single pole / single throw switches from the coach loads to the batteries, I can select either battery or draw from both of them in parallel. Normally when driving, the starter battery is switched online so the vehicle alternator can take the burden of recharge. When parked, the auxiliary battery is switched online to run lights, water pump, short runs of the refrigerator, stereo, and transceivers (both high-frequency short-wave and VHF for local communications). I use a second, heavy-duty battery switch to alternate batteries from the communications loads as the HF transmitter will draw close to 20 amps if run at 100 watts output.

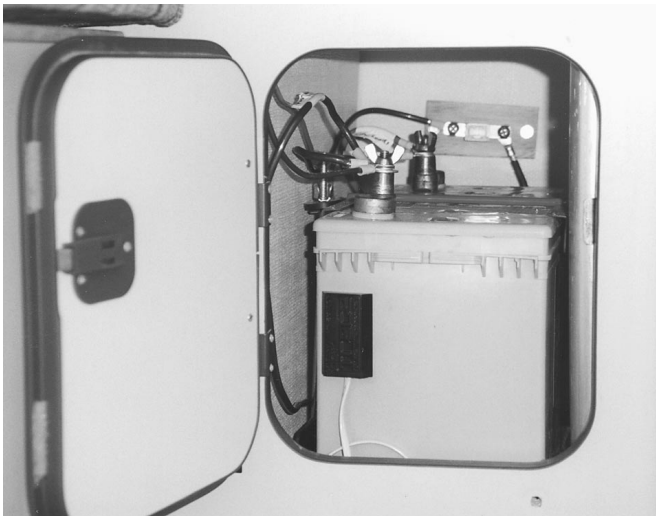
When we installed the Trace C-12 charge controller, it was brand new on the market. It had the features I was looking for, and then some. The big advantage of this controller is its three-stage charge which allows a much faster battery recovery, tapering off to a float charge as the battery reaches full. The pulse width modulation charge method is also a winner, as this decreases sulfation and is a perfect match for the gel cells. An added bonus was the built-in 12 Ampere low voltage disconnect. We got to test this feature on our vacation when I accidentally left the refrigerator connected to the starter battery while we went off on a day hike. On return, we had a disconnected load and a battery that would survive to see many more charge cycles! But, there wasn't enough juice left to turn over the starter motor, so both batteries had to be switched in parallel for a while until I had enough juice available to start the VW. Yes, I know this wouldn't have happened with an



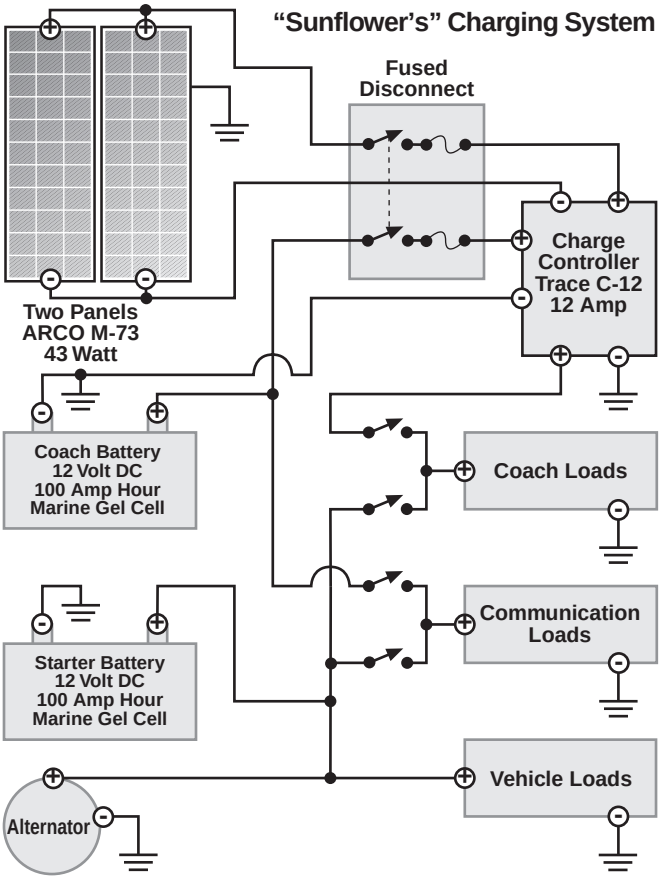
Above: Steve Bosbach (left) and friend work the ham radios during a hot Field Day.



Above (left to right): coach load switches, transmitter switch, C-12 charge controller—all wiring is behind the closet wall shown here.



Above: The Juice Box (a sealed lead-acid battery)—100 Ampere-hours at 12 VDC. The temperature sensor stuck to the battery goes to the charge controller.



isolator in the system, but I wouldn't have had the flexibility I have now. In a pinch I can parallel both batteries and run the refrigerator on DC for up to 10 hours without drawing down the batteries too much. Normally an overnight stop has us using propane for the refrigerator, but short stops of a couple of hours for sight seeing are much more convenient if run off DC.

The C-12 is also fully adjustable for on and off set points and needs to be set a tad hotter for gel cell batteries. I used the battery manufacturer's recommendations and set the float at 13.8 V and the low voltage reconnect at 12.8 V. High voltage disconnect for the bulk rate (first stage of charge) was set at 14.4 V and the low voltage disconnect is set at a conservative 12.0 V. The blinking LED is simple to interpret with a steady green for full charge and steady red for off (low voltage disconnect). In between there is a sequence of blinks, from an evenly spaced blink to a series of five blinks and a pause before going to a solid light. I found this system to be simple to interpret but not nearly as linear in showing state of charge as the front panel diagram would indicate. The C-12 LED goes from green to red when the battery falls to 12.6 V. The instruction flyer included does explain the amount of voltage difference between each step in LED

VW Westfalia Solar Conversion

#	*System Component*	*Cost*	*%*
2	ARCO 43 Watt PV panels	$240	34%
2	Lead-acid gel batteries	$240	34%
1	Trace C-12 charge controller	$116	17%
	Wire and Conduit	$43	6%
1	Marine battery switch	$32	5%
1	Circuit breaker 30 Amp 2 pole	$19	3%
2	Toggle switches	$6	1%
1	75A fuse	$5	1%
	Total	$701	

change, but the fact that this is not linear is not obvious. From the diagram on the C-12 it looks like 3 or 4 blinks of the green light would equal about 75% charge, when really the battery is still fully charged. The shift to red occurs at the 65% charge level! The battery manufacturer provided a charge curve for their gel cell battery and I simply printed out voltages for each 10% step in the charge curve. I pasted this to the side of the C-12 and now have a close approximation for state of charge by reading voltage directly off the battery with a digital multimeter. Eventually, I'll install a digital voltmeter right next to the C-12 so I don't have to dig out the multi-meter each time I want to check charge.

With the project completed and well tested, we named out little RV "Sunflower". In all, we are very pleased with our solar-powered van, and would encourage others to take the leap into PVs. This was a practical, small scale PV demonstration to teach myself the rudiments of solar electric power, and it was well worth the time and money spent. I'd like to thank Home Power for providing the seed that finally germinated and blossomed into this flower that follows the sun.

Access

Authors: Stephen and Crystal Bosbach, 16304 Westview Trail, Austin, TX 78737 • E-Mail: mwvw57a@prodigy.com

EXELTECH INVERTERS

camera ready
on negative

black and white
7.2 wide
4.6 high

COMM.POWER

Renewable Energy On-line

Michael Welch

Home Power Magazine announces its brand new World Wide Web (WWW) pages. For those on the Internet, just point your web browser at **http://www.homepower.com/hp**

WWW is a new way of accessing the Internet. It allows users to access "pages" (documents) that include attractively formatted text and graphics.

It's a powerful and popular tool for businesses, non-profits, and individuals to make information available to the world. It is very easy to make your own pages, too. Many Internet Service Providers (ISP) include free space on their web servers for anyone that has an account. For more information on making your own pages and accessing others' pages, just ask your ISP.

In addition to the software you need for accessing the Internet, you will need a web browser. Most browsers have no problems accessing our pages, but some don't support graphics and several of the formatting techniques we use. To take advantage of all our features, use the latest version of Netscape. If you want to use our WWW pages for on-line ordering of Home Power Magazine and other products, you must use a version of Netscape that provides security for credit card information. If you get hold of an older version of Netscape, there is a menu button to take you to Netscape's own WWW page that will allow you to grab their latest version for free!

Most features in our WWW pages are for those not yet familiar with the magazine. In the future we will make many of our back issues available and will include links to other renewable energy sites as well as our advertisers' sites. For now, WWW cruisers may get an idea of the principles of the magazine, find out the particulars for writing articles and doing business with us, find out what makes up a typical home power system, and subscribe or renew while on-line.

We have contracted our WWW site service from Green Marketing, a company set up for commercial web sites on the same system that houses EcoNet and PeaceNet.

Our site has a "secure web server" for credit card orders of our magazine and the Solar1 CD-ROM. A secure server works with the most recent Netscape browsers to scramble and unscramble confidential credit card data. When you send sensitive data, Netscape will automatically encrypt it before it is sent over the Internet. Our server then decrypts it with a key that only it has, re-encrypts it with a key that only HP has, and E-Mails it to us. We then use our key to decipher it and add it to our order database.

We are proud of our web pages. They are visually stimulating and have significant practical use within them. With some good promotion from the folks at Green Marketing, our web site should become a popular and practical tool for educating users about home-scale renewable energy.

Free Internet E-Mail from the HP BBS

Many do not need or want full Internet access. But, some still would like to have E-Mail, the most-used part of the Internet. With Internet E-Mail, you can exchange messages with anyone in the world that also has access.

For about a year, HP staff and associates have had Internet E-Mail access through the Home Power BBS. We are ready to offer free E-Mail to Home Power BBS users. There's a catch, though. We ask that you participate in the BBS in other ways in order to qualify. That means you become a regular participant in the message conferences and/or regularly upload usable files about energy-related subjects.

This free service normally carries a significant price tag, but we want to use it as a tool to promote the use of the BBS. The more usage it has, the more valuable it becomes as a resource. In case you are unable to participate or upload, but still would like to have Internet E-Mail access, we will give it to you for a very reasonable price. Please contact me as listed in Access.

Other Neat Things on the Internet
Our WWW pages aren't the only good things going on. You'll be amazed at the kinds of things you will run into. Like life itself, the WWW offers everything from Aunt Frieda's moose casserole surprise (It's good, though. With apologies to Utah Phillips.), to how to field strip your IBM PC. You will find some good, bad, and really weird things out there.

There is a great document that is updated regularly by CREST that lists hundreds of ways to access energy stuff on the Internet. You can download the document from either the Home Power BBS or directly from our new Web site.

As reported in HP #42, our back issues are still available at **sunSITE.unc.edu** in the directory **pub/academic/environment/alternative-energy/energy-resources/discussion-groups/newsgroups/alt.energy.renewable**.

Home Power Acrobatics
Several thousand of you have logged onto our Home Power BBS or accessed our Solar1 CD-ROM to obtain electronic copies of HP past articles. We have long been dissatisfied with the methods we've used to make the articles available. Each article has taken mucho effort to convert for all computer platforms, and the quality of the formats has been marginal.

Now emerges the Adobe Acrobat Reader. We first use software to take pages from our desktop publisher and change it into a format that can be used by the Readers. That way, you view the pages exactly as they are printed in the magazine. The Readers are available for free on the BBS and through our WWW pages.

We will be doing two sets of these files. The first is for our next Solar2 CD-ROM (yes, this is an official pre-announcement), which will be interactive and indexed. The second set will be for the Home Power BBS and our WWW page. The resolution will be lower for faster downloading.

Electronic Q&A
One of my favorite parts of Home Power Magazine is the Q&A section. But, depending on when you write us looking for an answer, it could be over two months before you see your reply in print, if at all.

You could always bug your renewable energy dealer, but wouldn't it be nice to have fast answers to these questions from HP staff and independent sources? And, wouldn't it be nice to have the advantage of several knowledgeable persons giving you the benefit of their experience?

Instant (almost) gratification can be yours! If you have a computer and a modem, you can get fast answers for the price of a couple of phone calls.

Think of the Home Power BBS as a huge Q&A central receiving area, with the staff of Home Power Magazine and many other interested people just waiting for your questions. Other users want your knowledge, as well. Here are some messages and responses as examples. There are lots of these on the BBS, and as more and more of you take advantage and contribute, the messages and levels of expertise should increase as well.

From: DAN FIELD
To: ALL
Subj: PV DREAM SYSTEM
I am in the process of building a suburban, PV powered (rammed earth, hydronically heated), utility-intertied home. The present plan is to mount M55s on Watsun trackers to total 3kWs. I will get the PV's at about $4.10 a watt and the trackers at retail. A Pacific Inverter has been selected. I have a tentative agreement to receive retail for any surplus power generated. I welcome any comments on this system, including criticism of the components, the mix, and any suggested cost savings... Because of the orientation of the house, I can't do a large static roof mount. Please make your comments. This house is in Fair Oaks near Sacramento, CA.

From: JOHN STANLEY
To: DAN FIELD
Ahhhhhhh... a fellow mud dweller!
I will soon be moving into my new house in Iowa which has exterior walls made of pressed earth blocks made from dirt right off the property. There are two 8" layers of blocks with a 4" insulated gap in between; plaster on the inside, stucco on the outside.

The heat is all hydronic in-floor. The heat will come from solar thermal, when there is sufficient sunshine and propane when there isn't. The foundation of the house is made of two layers of blocks made of 80% wood chips, 20% Portland cement, and filled with concrete with a total R-value of about 30. The slab, however, is uninsulated. The idea is that the cool ground temperature will help keep the house cool in summer.

Power comes from 3000 peak watts of PV and a Whisper 1000 on an 84' tilt-up tower, with a propane powered Onan as backup. The battery bank is a 24v affair composed of 76 ED-160 reconditioned NiCd batteries. We're using 19 cells per series instead of 20 so that we can use Trace inverters. The plan is to replace the present Trace with their new humongous pure sine wave inverter, thus obviating the need for a

separate sine wave inverter for the TV, stereo and computer.

For active cooling there is a huge earth tube made of concrete well tile buried 10' beneath the ground. A fan in the small basement under the kitchen will draw outside air into the house through the earth tube, thus providing naturally cooled air to the house. If the earth tube is insufficient, then it will be possible to add additional cooling capacity in the form of a coolant loop between a heat exchanger in the earth tube and a loop of tubing submerged at the bottom of the 27' deep adjacent pond.

From: BOB SIEBERT
To: EVERYONE
Subj: LINE-TIE INVERTERS
I am planning a PV installation in an area served by the grid. Two inverters seem able to do the job: My first choice has been Pacific Inverters, a unit designed specifically for this job. Another option now seems to exist, the new Trace sine wave unit. It requires batteries, but I'm not certain about the relationship, if any, between array size and battery bank size. Any thoughts you have on these two inverters, or others suitable for line tie and sale of daytime power to the utility, would be appreciated. Sincerely, Bob Siebert

From: Michael Welch
To: BOB SIEBERT
To quote from the Trace 4024 manual, "Batteries are required for utility inter-tie operation. The batteries can be small, if there is not requirement for back-up power in the event of utility failure. Two thousand watt/hours is sufficient (100 amp/hours at 24 volts is 2400 watt hours)."

You might consider a slightly larger battery to cover more serious brown-out situations.

That's what it's like on the Home Power BBS. If you can take advantage of this type of interchange, or are willing to share your expertise with its users, please check in and contribute.

Using the BBS Without Exorbitant Phone Bills
It's easy if you use an off-line reader. Off-line readers are software packages that allow you to read and respond to BBS messages without being on-line the whole time. Their only real drawbacks are they take some setting up and getting used to, but that can be expected in this day and age of computer communications. There are several off-line readers available in the Utility Files section of the Home Power BBS.

Here's the basics, once you have your offline reader software. On the main menu of the BBS, choose <Q> for the QWK Off-line Reader Utility. The first time you use it you'll be prompted for configuration information. From the QWK main menu, you then choose <D> for Download Messages. The BBS will automatically gather all the new messages, compress them into a special file, and take you through the download process. Then you exit the BBS, hang up your modem, and exit your communications software.

Now, start your off-line reader software. The reader will decompress all the messages and allow you to read and respond to them one at a time. When you exit the reader software, it will automatically compress all your replies into a format ready for uploading to the BBS.

Then, call the BBS with your regular communications program, enter the <Q> Off-line Reader Utility, and choose <U> for Upload Messages. The BBS will take you through the upload process and once it has your replies, automatically place them in the BBS message areas, just as if you had responded on-line.

There are lots of little things that can be configured in off-line readers, so if you get confused, stay with it or contact me. It will be worth the effort once you start saving on phone bills.

Getting Home Power Magazine Info Via E-Mail
The Home Power Internet E-mail connection has set up a way for Internet users to automatically get HP magazine information. Send a message to the following addresses to get the specific info. The content of the message is not important, just the address.

hp.whats@homepower.or
What is HP magazine?

hp.bus@homepower.org
HP Magazine business & advertising

hp.index@homepower.org
HP Magazine index of articles.

hp.writers@homepower.org
Writing for HP magazine.

hp.sub@homepower.org
Subscription form for HP magazine.

solar1.cdrom@homepower.org
Solar1 CD-ROM information.

hp.bbs@homepower.org
Info on Redwood Alliance, the Home Power BBS, and downloading articles.

Access
Author: Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95521. (707)822-7884 voice, (707)822-8640 computer BBS,
Internet E-Mail: michael.welch@homepower.org

Things that Work!

Things that Work!
tested by *Home Power*

The Freedom 25 Inverter with Link 2000

Richard Perez

Heart Interface's Freedom 25 is a powerful 2,500 Watt modified sine wave inverter with a built-in 130 Ampere battery charger. In our testing it is reliable, very stable, and with the addition of the Link 2000 instrument, highly automated. After ten months of daily use, the Freedom 25 and the Link 2000 passed rugged "Things that Work!" testing with flying colors.

Above: Heart Interface's Freedom inverter/charger

Product Specifications

The Freedom 25 inverter we tested was a 12 Volt model. In addition to being a modified sine wave inverter, it also functions as a 130 Ampere battery charger. The charger is sourced by 120 vac from either the grid or from an engine generator. The charger is equipped to "power share" with small engine generators and limited 120 vac services (like a boat dock). The charger performs a three stage recharging process which is optimized for lead-acid batteries. There is also an equalization function on the charger which allows up 16.3 VDC for equalization. The inverter/charger itself measures 12 inches by 11.5 inches by 8.75 inches and weighs 56 pounds. The voltage input range of the 12 Volt Freedom 25 is 10.0 to 15.5 VDC. The unit is overload protected by both electronic shutdown and a circuit breaker, and also has automatic high or low battery shutdown. This 12 Volt Freedom 25 inverter/charger is UL listed.

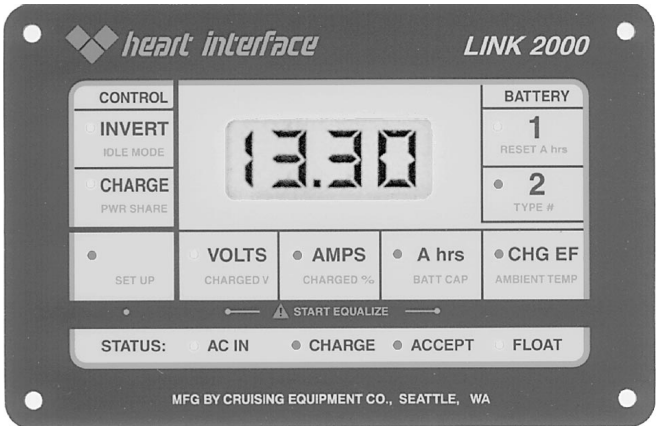
The Link 2000 is a combination inverter control and system instrument. The user can set the various inverter and charger parameters remotely by using the Link 2000 control. The Link 2000 will also measure system functions such as battery voltage and current, power source (PV, wind, or hydro) voltage and current, and battery ampere-hours (and even battery watt-hours). The Link 2000 is a super sophisticated computer which measures, accumulates and stores many different kinds of data. In addition to the functions mentioned above, it can also tell you interesting bits of info such as how many Ampere-hours or kiloWatt-hours your PVs made this week (or this month or year). It constantly calculates battery efficiency and displays this up dated number. It records the average depth of discharge which the battery undergoes. It records the deepest depth of discharge that the battery has undergone.

Documentation and Packaging

Heart's documentation and packaging is outstanding. The manuals are detailed, with simple step-by-step, profusely illustrated instructions. The installation manual is 11 pages, while the owner's manual is 36 pages. The Link 2000 comes with its own 28 page manual. This depth of documentation is necessary because the Freedom 25 and Link 2000 can perform so many different functions. The user can program the Freedom/Link system to exactly match his requirements. We had no problems setting up the Freedom/Link system, it was just a matter of following the directions.

The Test System

Ten months ago, we installed the Freedom 25 and the Link 2000 in Jim and Laura Flett's system in Northern



Above: The Link 2000 inverter/charger control and system instrument.

California. For a profile of this system see Home Power #13. This system has been functioning for over ten years now, and the Freedom 25 replaced an older model Heart Interface 1,200 Watt inverter/charger that ran faultlessly for all that time. The Flett's system is currently sourced by twelve Kyocera PV modules and a 6.5 kW Honda engine generator. Energy is stored in ten Trojan L-16 lead-acid batteries (1,750 Ampere-hours at 12 VDC).

The Freedom 25 was mounted in the battery room while the Link 2000 instrument/control was mounted right next to the kitchen in a high traffic area. The Freedom/Link setup made it easy to mount the inverter in the power shed outside the house and still maintain control and information functions inside the house.

Test Results

We used four Fluke 87 digital multimeters to make the measurements. These are true RMS reading meters and will accurately measure the electrical parameters of a modified sine wave. We measured the input battery voltage to the inverter, the current into the inverter, the rms and peak to peak voltages of the inverter's output and the inverter's output current. We also examined the inverter's waveform on a Hewlett-Packard oscilloscope. Here is the data.

Of particular note is the very tight output voltage regulation. We measured less than 3% deviation while Heart spec is 5%. This is a very stable inverter. We also confirmed Heart's specifications for efficiency. We measured 95% efficiency at 506 watts output (Heart claims 94%). At Full inverter output (2451 Watts measured) we saw an efficiency of 87% (Heart claims 86%).

After ten months of regular use, the Flett's have used the battery charger many times. It runs to Heart's specs on their 6.5 kW Honda generator. The inverter has performed flawlessly and powers all their 120 vac appliances including the washing machine.

The Link 2000 checked out when compared to measurements made by the Fluke 87s. Being able to control the inverter/charger and have the system instrumentation in a single, remote-mounted, package

Heart Freedom 25 Inverter Test Data

Output Side - 120 vac			*Input Side - 12 VDC*		
Volts AC	*Amps AC*	*Power Watts*	*Volts DC*	*Amps DC*	*Eff. %*
120.0	0.00	0	12.86	1.2	0%
119.6	0.21	25	12.82	3.1	62%
119.0	0.40	47	12.79	5.0	74%
120.0	0.85	102	12.75	9.3	86%
119.9	1.06	127	12.71	11.3	88%
119.9	1.25	150	12.68	13.2	90%
119.8	1.70	204	12.75	17.6	91%
120.2	1.91	229	12.68	19.6	92%
120.2	2.19	263	12.70	22.3	93%
120.0	2.50	300	12.62	25.6	93%
119.7	2.98	357	12.55	30.0	95%
120.3	3.35	403	12.48	35.0	92%
119.7	3.82	457	12.43	39.0	94%
120.0	4.22	506	12.39	43.0	95%
119.2	4.69	559	12.36	48.0	94%
119.1	5.03	599	12.67	51.0	93%
119.7	5.89	705	12.52	60.0	94%
120.7	6.77	817	12.37	71.0	93%
120.0	7.56	907	12.28	80.0	92%
120.7	8.42	1016	12.20	90.0	93%
121.4	9.29	1128	12.12	101.0	92%
120.4	10.04	1209	12.30	108.0	91%
120.2	10.32	1240	12.25	109.0	93%
121.3	11.20	1359	12.06	121.0	93%
120.8	12.02	1452	11.97	133.0	91%
119.9	12.80	1535	12.28	138.0	91%
121.2	13.70	1660	12.04	152.0	91%
122.1	14.60	1783	11.93	165.0	91%
122.3	17.20	2104	11.80	202.0	88%
123.8	19.80	2451	11.83	239.0	87%
124.0	22.20	2753	11.62	271.0	87%
123.4	23.20	2863	11.66	283.0	87%

is very convenient. I have personally been testing another Link 2000 here at Agate Flat since February of 1994. I have been keeping detailed records of the Link's data and comparing it with data from a Cruising Equip Amp-hour +2. The Link 2000 is highly accurate, displays more data than the Cruising, and I love its nonvolatile memory. You don't lose data if you disconnect the meter from its power source. I learned two interesting bits of data from Jim Flett's Link 2000. His average depth of battery discharge has been 223 Ampere-hours over the last ten months. His deepest depth of battery discharge during the same period was 776 Ampere-hours. The Link 2000 instrument made these measurements not only possible, but also accurate.

Conclusions

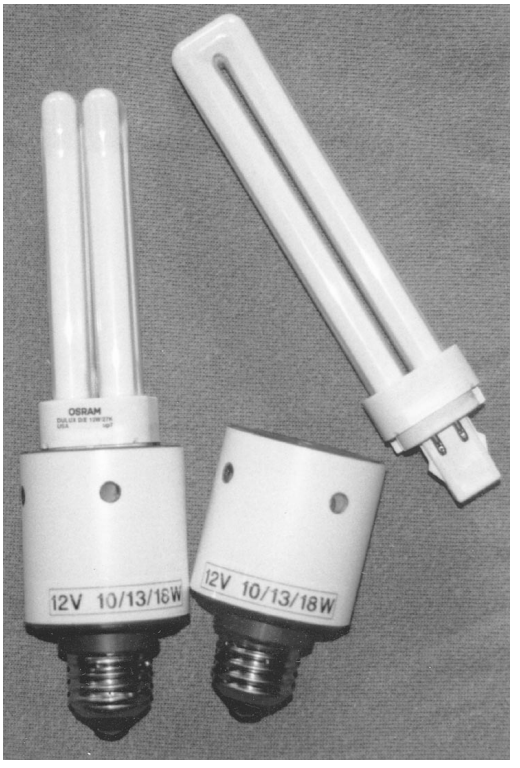
Heart Interface's Freedom 25 inverter/charger and Link 2000 control/instrument is a powerful, stable, and reliable combination. The inverter is very stable— 120 vac rms voltage varied less than 3% in our tests. The charger is powerful and can deliver a whopping 130 Amperes to the battery. The Link 2000 makes inverter programming easy and delivers accurate, detailed system data. The retail cost of the Freedom 25 is $1,990 and the optional Link 2000 costs $525. Both are worth it!

Access

Author: Richard Perez, c/o Home Power, PO Box 520, Ashland, OR 97520 • 916-475-3179 • Internet E-Mail: richard.perez@homepower.org

Many thanks to the crew of intrepid inverter installers and testers: Bob-O Schultze, Ben Root, Rick Proctor, and Warren Stokes.

Manufacturer: Heart Interface Corporation, 811 - 1st Avenue South, Kent, WA 98032 • 206-859-0640 • FAX 206-859-3579



GoPower

Secretary of Energy Hazel R. O'Leary gives Cal Poly Pomona the green flag in Indianapolis and Sunrayce 95 begins.

Checking out the cockpit is standard fare when a solar car is at rest.

MIT driver Goro Tamai is ready and confident.

Clarkson University placed 2nd in the artistic design competition.

Sunrayce 95

Michael Coe

With dreams of glory—and solar-powered cars so efficient they reached highway speeds using less energy than an average blow-dryer—the top teams arrived in Indianapolis for Sunrayce 95. Most of the teams from 46 North American colleges and universities were just hoping to qualify for the grueling nine-day, 1,250-mile race—the biennial intercollegiate cross-country solar car race. Other teams had different intentions—they were there to dethrone the University of Michigan, which ruled the 1990 and 1993 races.

The Massachusetts Institute of Technology was the wild card. The team itself wasn't sure if it was a contender. "We don't know," said team captain Goro Tamai. Of the 65 teams entered in Sunrayce 95, the top 30 teams were seeded based on technical proposals submitted in 1994. MIT didn't make the cut. Fortunately, rules limiting solar array size and power helped MIT build a competitive car on a small budget. "With the new rules, Sunrayce is a brain race, not a money race," said Tamai.

Sponsored primarily by the U.S. Department of Energy and General Motors Corporation, Sunrayce 95 is a two-year educational experience that provides more than 2,000 students with a hands-on learning experience.

"Sunrayce is all-encompassing," said Tamai. "You learn about engineering, manufacturing, project management, and fund raising. My educational experience at MIT wouldn't have been nearly as complete without Sunrayce. There are some things you can't learn from a book."

The Sunrayce experience culminates with the cross-country race. To compete in the race, cars must pass a rigorous inspection to ensure compliance with structural and safety requirements. They must also drive at least 50 miles around the Indianapolis Raceway Park track averaging 25 mph. Over a three-day period from June 16-18, thirty-eight cars qualified for the race.

The race would start June 20 in downtown Indianapolis and finish June 29 at the National Renewable Energy Laboratory in Golden, Colorado. The team with the lowest cumulative time would win.

Race Route Diary

Day 1

Secretary of Energy Hazel R. O'Leary waved the green flag to start Sunrayce 95. The cars left at one-minute intervals based on qualifying position. With the sun shining powerfully overhead, Cal Poly Pomona and MIT, the top two qualifiers, engaged in a heated battle over the day's 65 mile course. The teams exchanged the lead repeatedly, at times racing down the road side-by-side. Both teams averaged 36.1 mph for the course, with Cal Poly taking the finish line 5 seconds ahead. The University of Missouri-Columbia finished third, Mankato and Winona State Universities fourth, and the University of Minnesota fifth.

Day 2

Cal Poly Pomona set the early pace, reaching 50-55 mph on open highways. Ninety minutes into the 169-mile leg, Cal Poly's motor controller overheated, and the team pulled over to repair it. MIT moved into the lead, took a wrong turn, and lost the chase vehicle in the U-turn. Tamai didn't notice, got back on the correct route, and confused another chase vehicle for his own. While the team still finished first for the day, MIT was accessed a 15-minute penalty for separating from its chase vehicle.

The big story was Northern Essex Community College from Haverhill, Massachusetts. With one of the smallest budgets, the team built an ultra lightweight car and a folding array that gave the team one of the best size-to-power ratios of any car in the race. Northern Essex stormed the field, catching all but three teams.

Mechanical failure of Michigan's custom-built magnesium wheels forced them to trailer their car to the finish line. Behind by seven hours, they had little chance at a third straight Sunrayce title.

Day 3

Minnesota set a new Sunrayce record for average daily speed racing along the banks of the Missouri and Mississippi rivers. Cal Poly Pomona faired badly. They watched the other leaders rip past them while fixing two flat tires.

Minutes from the finish, Northern Essex's car blew a tire and spun off the road. Scouting Minnesota team members helped Northern Essex repair the tire and the

team took first place for the day, minutes in front of MIT and Minnesota. With Northern Essex and MIT assessed penalties, Minnesota won the day's leg, averaging 43.7 mph over the 165-mile leg and breaking Cal State LA's record for this stretch. Nineteen hours back, and out of contention, was Michigan, who trailered the vehicle with a problem they couldn't fix.

In sixth place, George Washington discovered that their array was allergic to the sun. The silver epoxy material used to mount the solar cells reacted with the cells' aluminum backing to create a chemical reaction that restricted the flow of electricity.

Day 4

The 156 mile course from Fulton to Lee's Summitt, MO was a solar racer's dream. The sun-drenched course was flat, had few traffic lights and was mainly open, four-lane highways. Minnesota, Northern Essex, MIT and Cal Poly Pomona smoked the course from start to finish. Northern Essex got the jump on Minnesota after a red light and arrived at the finish line first. A 25-minute penalty assessed to Northern Essex gave Minnesota the win and a new speed record—47.7 mph. "If you told me three weeks ago that our car would be going up hill at 55 miles per hour, I wouldn't have believed it," said a jubilant Jessica Gallagher, Minnesota's team captain. She wasn't alone. The top cars were finishing 1-2 hours faster than Sunrayce officials had predicted.

Overall, MIT now led Pomona by nine minutes, Minnesota by 10 minutes and Northern Essex by 42 minutes. In fifth place, 91 minutes behind MIT, sat George Washington, the team most experts thought had the best car.

Rest Day

Problem-plagued Michigan quit after a tire blowout on Day 4 almost caused their car to swerve into on-coming traffic. "It's really sad," said team manager Betsy White. "We worked for two years for this race." In a gesture of sportsmanship, Michigan donated some of its spare tires to MIT. The day also brought the first rain of Sunrayce 95. It continued into the night.

Day 5

Bad weather is usually a solar car's nemesis, yet George Washington's car performed beautifully as dark clouds and rain covered the 152-mile course from Lee's Summit to Manhattan, Kansas. George Washington arrived first, 47 minutes ahead of the second place vehicle. Now, just 38 minutes separated the top five cars in the overall standings.

Day 6

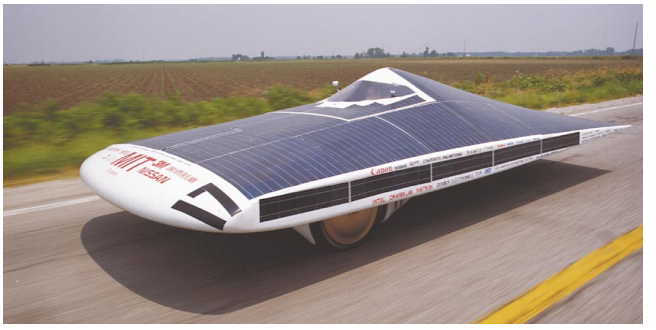
Overcast skies greeted the racers. By midday of the 150 mile leg, George Washington was 22 minutes in front of MIT. Then, motor controller problems forced them to slow down, and MIT cut into their lead. George Washington finished first for the day (moving into second place overall) 18 minutes behind MIT. Minnesota finished third, Cal Poly Pomona fourth, and the battery-depleted Northern Essex fifth.

Day 7

The 166 mile course from Smith Center to St. Francis,

Drexel passes through a small, midwestern town.

Cal Poly Pomona team-members attaches the solar array for another day of racing.



The University of Minnesota crosses the finish line for a 2nd place title.

The MIT (Massachusetts Institute of Technology) car won Sunrayce '95 with the fastest average speed yet for the 1,150-mile race— 37.2 mph.

Where's the Motor?
After observing a similar setup in Australia's Northern Territory University, the George Washington team built a hub-motor for their racer. "It took four students a year to design and build the motor," said captain Kory Knudtson. The hub-motor eliminated the transmission, increasing the car's efficiency. Sunrayce 95 officials honored the team with a technical innovation award. The vehicle also won the artistic design competition.

Where's the Solar Array?
Northern Essex Community College had a grand concept—build the lightest, most powerful car in the field. The lightweight, bullet-shaped car had a 1,350 Watt folding solar array that was stored in a rear compartment during racing. While other cars could run directly off sunlight, the Northern Essex car could not. Instead, the car ran solely off batteries. Fully charged, they provided 220-230 miles. As needed, the team stopped and deployed the array.

Keeping Cool and Efficient
Messiah College from Pennsylvania developed an ingenious system to keep their solar cells cool and gain an advantage. They used aluminum foam and air ducts to cool the array. The team mounted the cells onto the foam, a rigid, lightweight material. The foam provided structural support for the solar cells. Air ducts built into the top of the car channeled air underneath the array and exhausted the heated air out the back.

Kansas had few towns or stoplights. In a tremendous display of speed and efficiency, Minnesota averaged 50.4 mph for the day, all the more remarkeable considering the 1,700 foot gain in elevation. MIT averaged 49.3 mph and finished within four minutes of Minnesota. "We didn't realize how fast we were going until about ten miles from the finish line," said Minnesota's Scott Grabow. "It was our fondest moment." With only 223 miles of racing left, Minnesota knew they couldn't outrun MIT. "Our only chance to win is if MIT has a breakdown," said Grabow.

Day 8
The 171 mile course from St. Francis to Aurora, Colorado was the race's longest leg. It gradually rose 2,500 feet in elevation, too. Dark, ominous clouds hovered over Aurora. Northern Essex attacked the hardest, but couldn't sustain the pace and stopped to recharge. Cal Poly Pomona passed MIT and Minnesota with 30 miles to go, won the day, and moved into third place overall. MIT's overall lead over Minnesota was 49 minutes. Heavy thunderstorms postponed solar charging of depleted batteries that evening.

Day 9
Cold, dark and wet conditions ruled out early morning battery charging. "We don't know how much energy we have in our battery," said Tamai, so MIT planned to drive just fast enough to win. Other teams, knowing they didn't have enough battery storage to make it to the finish, replaced their depleted battery packs with fully charged packs or used a generator to charge their batteries—absorbing a 5.5 hour penalty. Many teams tried to make it under their own power, and crawled to the finish line.

MIT experienced its first breakdown of the race. Rain had seeped into the car and damaged the motor controller. The team fixed the problem in 15 minutes, but Minnesota had passed them. MIT was only traveling 10-15 mph. How far ahead was Minnesota? "We were getting reports that Minnesota had already finished," said Tamai. A tire blowout ten miles from the finish cost Minnesota several minutes, but they crossed the finish line at the National Renewable Energy Laboratory in Golden. Out came the stopwatches.

Thirty minutes later, MIT crossed the finish line to win Sunrayce 95. After 1,250 miles and nine days of racing, MIT had finished just 18 minutes and 49 seconds in front of Minnesota in the closest Sunrayce finish ever.

"I didn't know we had won until Jerry Williams (a Sunrayce official) handed me the checkered flag," said Tamai. MIT averaged 37.23 mph for the 1,250-mile course, breaking Michigan's 1993 record by 10 mph.

Rounding out the top ten overall were: Cal Poly Pomona third, George Washington fourth, Stanford fifth, Queens University sixth, Northern Essex seventh, Western Michigan University eighth, Mankato and Winona State Universities ninth, and the University of Missouri-Columbia tenth.

When the next Sunrayce event is held in 1997 over a similar route, Tamai won't be there to help MIT defend its title. He will, however, always remember winning the 1995 race. "It was the absolute highlight of my college career," he said.

Access

Michael Coe, Public Affairs Office, National Renewable Energy Laboratory, 1617 Cole Blvd., Golden, CO • 303-275-3000.

SNORKEL STOVE

camera ready
b/w

3.4 wide
3.4 high

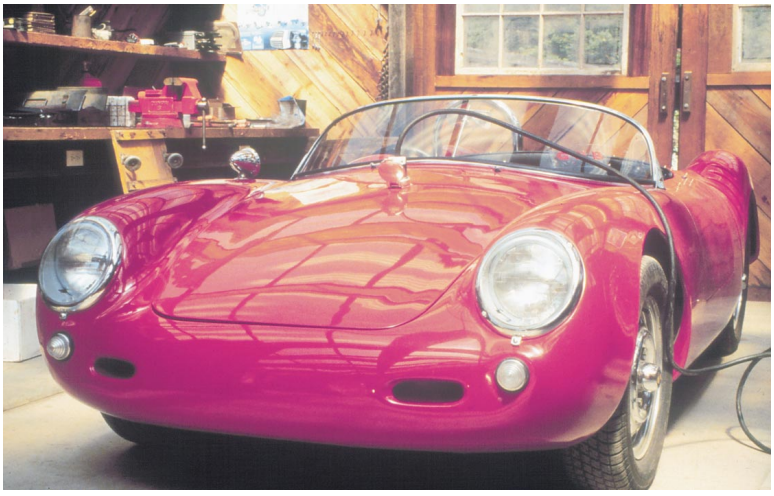
A rooftop of solar panels supplies homestead power and recharges an EV.

Solar Energy for Home & Car

Stephen Heckeroth

When it comes to resource depletion and air pollution, the automobile remains the real culprit. Transportation uses four times the energy that is used in housing and causes about ten times the air pollution because of its total reliance on petroleum. It was this realization that led me to mortgage my home and start MendoMotive, an electric vehicle company.

A Porsche 550 Spyder replica body weighs only 1000 lbs.



(R to L) Mendomotive's crew:Stephen Heckeroth, Norm Fluhrer, Dick Hamilton, and Gary Glo with the winner of the 1995 SunDay Challenge at Daytona International Speedway.

Changing the image of electric vehicles from golf carts to high performance cars can easily be accomplished. A more fundamental issue is achieving mobility without pollution.

A 3,000-watt PV array, water-heating panels, and skylights make up this barn roof.

The Spyder is lightweight and good looking.

Gary Flo and Norm Fluhrer of Mendomotive show off prototype 20HP tractors converted to electric power.

Since the late 60s I have been concerned about the depletion of non-renewable energy resources and the pollution caused by their use. As an architect I have channeled my concern into refining residential passive solar design. I am now confident that with good solar access, I can design a home that will have all its energy needs satisfied by the sun.

Electric Cars

In 1992 I started converting everything I could get my hands on with off-the-shelf golf cart and forklift technology. In a search for the lightest possible vehicle, I found that a fiberglass Porsche 550 Spyder replica weighed less than 1,000 pounds. MendoMotive's first vehicles used 120 Volt at 400 Amp controllers, 9-inch advanced DC motors, and golf cart batteries. This resulted in vehicles with 50 HP drivetrains and ranges up to 100 miles. There was no regenerative braking capability and acceleration was about equal to an early VW Bug. Few chargers were available and it took 8–10 hours for a full recharge.

The California zero-emission mandate has fueled research and development around the world and new products are surfacing on the market almost weekly. Currently there is a wide variety of affordable controllers on the market with regenerative braking and up to 320 Volt and 1,000 Amp capacity, offering in excess of 300 hp. High voltage motors are also being produced that offer much higher torque than current production models.

Designed and built by Stephen Heckeroth, this tower house integrates solar panels.

Integrating PV and water-heating panels while re-roofing the barn is cost-effective and a relatively simple process.

A Type II Karmann Ghia plugs in while parked in the garage.

Other battery types—Bi-polar, sealed lead-acid, nickel-metal-hydride and zinc-air—are all available on a prototype basis, offering up to four times the range for the same weight. Like any prototype, this new generation of batteries is expensive but the cost will drop when volume allows mass production. Chargers are now on the market capable of full recharge in as little as 15 minutes.

I have upgraded my Type III Karmann Ghia with a new ZAPI controller. It has a regenerative braking circuit capable of producing over 115 brake horsepower. The regenerative braking increases range by 15% in hilly terrain. It also reduces brake wear enough to make replacing the tires the only regular maintenance required on my TYP3EV.

We can now produce an electric Porsche that will outperform the original gas version in every category except range. Performance is no longer an issue. With new generation batteries and quick recharging, range will be equivalent to current polluters. Nickel-metal-hydride and zinc-air batteries are non-toxic and offer much safer energy storage than a potentially explosive gas tank. When demand takes the production of EVs to the assembly line, their cost will drop to equal or less than the cost for an equivalent gas car.

Changing the image of electric vehicles from golf carts to high performance cars can easily be accomplished. A more fundamental issue is achieving mobility without pollution. This issue can best be addressed by planning our communities around pedestrians and ultra-light vehicles. For now, this country has an infrastructure of roads designed for cars which have become less of a means of transportation and more a symbol of people's identity. Electric cars are the best transition to clean and quiet pedestrian communities.

Opponents of electric cars argue that emissions are only transferred from the tailpipe to the smokestack or the nuclear power plant. This argument can be put to rest when photovoltaic charging stations are integrated into the roofs of our homes, and the places where we work, shop, and recreate.

Selecting the Roof-mounted Panels

Typically, a roof's main function is to keep the rain out while maintaining a comfortable indoor temperature. When photovoltaic panels are used as roofing, the roof takes on a dual function by converting the sun's rays into electricity.

Crystalline, poly-crystalline, and amorphous are the commonly available kinds of photovoltaics. Crystalline and poly-crystalline are about 10% to 12% efficient in their conversion of sunlight into electricity, compared with 4% to 8% efficiency for amorphous panels. The overall efficiency of thin film amorphous silicon panels, when compared to stationary crystalline panels, is increased by their ability to more efficiently convert indirect or diffused light. This also makes the amorphous panels very useful in areas with extended periods of overcast skies.

Another advantage of amorphous technology is that the manufacturing process is more environmentally friendly. The thin film is applied without any waste, while significant material loss results from the manufacture of crystalline panels. The energy consumed in the manufacture of thin film amorphous panels is recuperated in as little as two months of use, as opposed to up to five years for crystalline panels. Since the thin film amorphous silicon adheres to materials that also make good roofing, like metal, glass and ceramics, it becomes versatile as a building material.

United Solar Systems Corp. (Uni-Solar), is experimenting with a variety of amorphous silicon panels that, once on the market, could turn all south-facing roofs into charging stations. The modules Uni-Solar is developing are metal-based units. The thin film is applied to steel and covered with a protective coating for roofing uses, producing 800 Watts per 100 sq . ft.

Advanced Photovoltaic Systems [APS], until recently, manufactured laminated glass panels capable of producing 400 Watts per 100 sq ft. The panels were installed on the south-facing roof of our barn, replacing a leaky metal roof. The cost of new roofing material ($2 per sq ft) was avoided. The labor involved in putting up the panels was approximately equal to replacing the old roof with new roofing material. So the integrated PV installation cost $8 per sq. ft., when you include the avoided cost of new material.

The barn's 700 sq. ft. array produces a steady three kW for seven or eight hours a day in the summer and 1.5 kW for four or five hours on a cloudy winter day. This yields a yearly average of 15 kWh a day. Using the new California net metering law (where the utility must pay the same rate for home-produced power that is fed into the grid as they charge for electricity from the grid) and time-of-use rates, I expect the array to produce about $7.50 worth of electricity per day in the summer and a low of 75 cents per day in the winter. This means an avoided expense of approximately $4 a day or $1,500 a year. The system, including the Trace synchronous inverter and batteries, will pay for itself in less than seven years. Over its 30-year expected life, the PV roof will generate $45,000 of "avoided" utility bills even in the unlikely event where utility rates remain constant.

The 3,000-watt array is capable of providing all the power for our house and an apartment in the barn loft. Our electric car and tractor can also be charged on sunny days.

Solar charging should ideally be available where people spend their days—at work. Maybe businesses should be required to have solar charging stations the way they are required to have parking places.

Electric Tractors

While battery weight is an obstacle to performance on the road, it is an *asset* in the field. The batteries in a well-designed electric tractor add stability and traction. With the addition of an on-board inverter, even a small electric tractor can be used as a clean and silent

mobile power source for garden and construction tools, in addition to powering most (or all) of a home. Solar charging can be accomplished over several days for use on a weekend or as an emergency power source. An electric tractor has fewer moving parts, requires less maintenance and, if mass produced, would cost the same as a comparable gas version.

MendoMotive's sister company Electrac has already converted several 20 hp tractors that are as powerful as their original diesel incarnation. We are currently seeking capital to build a production prototype—a cordless lawn and garden tractor—that will cut both pollution *and* the grass.

The solar age is already here, but it is individual action that will lead to a reduction in the use of non-renewable polluting energy resources. Please take action.

Access
Stephen Heckeroth, MendoMotive, 110 W. Elm Street, Ft. Bragg, California 95437. Phone (707) 964-1331 Fax: (707) 964-6500.

Part three

Wild Cat One

Clare Bell

Now we start fabricating and assembling parts for the most complex part of the vehicle, the V-belt transmission. Exercise your domestic archaeology and dig up Part 1 (HP #48, p.52) and Part 2 (HP#49, p.62) of this article.

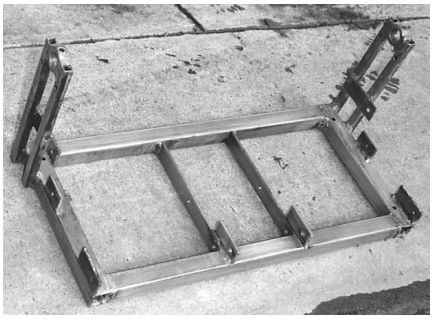
Implements of Mayhem (Tools)

Wrenches: 11 mm open/box end 5/32" hex (allen) key (for capscrews) 1/8" hex (allen) key (for setscrews)

Ratchet drivers, sockets, ends, adaptors: 3/8" ratchet driver with 3" extension, 3/8" socket - 11 mm 3/8" breaker bar, C-clamps or vice grips, centerpunch, hammer or mallet

Power Tools

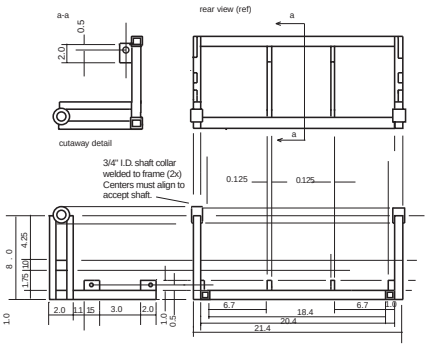
Bandsaw (so much easier than a hacksaw!) MIG Welder Electric drill or drill press with 3/4" chuck and 5/16" bit and chamfer bit. A mechanic's vice is recommended. It helps to have access to: a stationary belt sander, bench grinder and lathe (for radially symmetric parts such as bushings and shafts).



Preserving Mind & Bod (Mechanical Building Tips)

Here are a few suggestions to prevent skinned knuckles, nicked fingers and lost tempers. Building this vehicle should be a joyful experience, not a hassle. So:

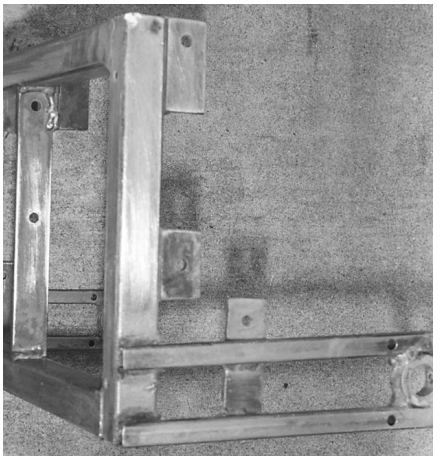
1. Don't rush. Take time to measure carefully, centerpunch holes before drilling and sand off burrs.
2. Don't force. Well-made parts go together easily. If they don't, something's wrong. Find it and fix it.
3. If you get stuck, take time out or ask for help. Don't work while you are tired or frustrated. That is when safety precautions get neglected and accidents happen.
4. Finish your parts. Round edges and corners and bevel hole edges with a chamfer bit. Parts should feel good to handle.
5. Pull, don't push on wrenches. If you have to push, do it with an open hand to save busted knuckles.
6. Use the right wrenches. Don't get seduced by adjustable crescent wrenches. They slip and chew up parts.
7. Use 1/4-28 fine-thread bolts, capscrews and nuts. The fine-threads are stronger. If you can't get them, use regular 1/4-20s.
8. Nylok nuts prevent loosening due to vibration, however don't put them on until the transmission is together and running the way you want. Nyloks are difficult to remove and are only good for 6 installations/removals. While building and testing, use regular nuts and lockwashers.
9. Shaft collars and bushings will jam if your shaft has burrs or nicks. Shaft collar setscrews make circular gouges when torqued down hard. Avoid gouging by grinding the bottom end of the setscrew flat. If you do burr up your shaft, sand it smooth.
10. Install keys when mounting sprockets and pulleys on jackshafts or motor shafts. A setscrew alone won't hold.



Instructions

Frame

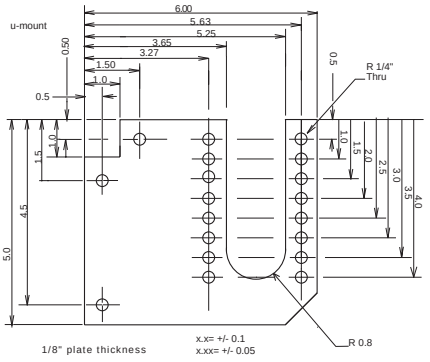
This frame is welded square steel tubing (Photos 1 and 2). You can also build it out of Jergensen box-beam, (but no Erector sets please!) Attached 3/4" shaft collars hold the main axle. The collars MUST be parallel with each other and the frame members or else you'll be



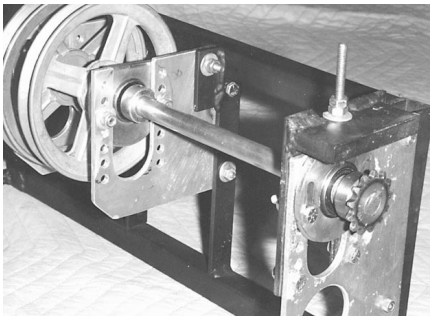
Left: Photo1, Frame

Right Above: Frame diagram, welded or bolted assembly using 1" & 1/2" square steel tubing.

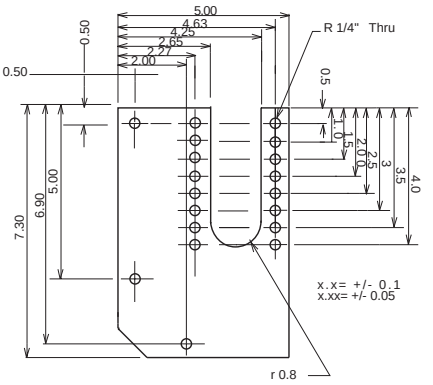
Right Below: Photo 2, Frame detail



Above: Inboard U-Mount Plate
1/8" Aluminum Plate Thickness



Above: Photo 3
Jackshaft mounted in Frame



Above: Outboard U-Mount Plate
1/8" Aluminum Plate Thickness

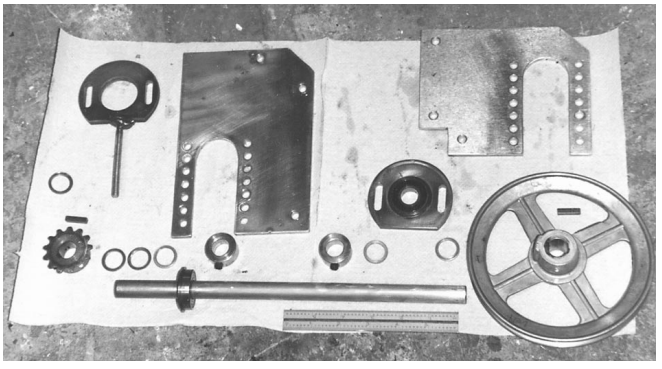
grunting and cussing when the axle jams. Powder-paint or paint your frame to prevent rust.

Rube Goldeberg's Delight (V-Belt Transmission)
This contraption has two jackshaft assemblies, each with a V-belt driven pulley on one end and a drive sprocket on the other. (Photo 3) The drive sprocket end also includes a chain tensioner. The motors themselves are in the footpedal controls.

Jackshaft Assembly
You will need the frame plus all the parts shown in the accompanying layout (Photo 4).

Some items come from a commercial 5/8" X 10" jackshaft kit, item # 13815-C086 in the Northern Hydraulics catalog (1-800-533-5545). Some are hardware store items (the belts and pulleys came from Orchard Supply Hardware) and some you must modify or fabricate.

Fabricated Parts.
The U-mount plates are made from scratch. You need 1/4" steel plate. Cut and drill according to the two accompanying drawings. The rows of holes are on 0.5" centers. Make the chain tensioner bridge from two steel flat sections and a thick triangular flange.



Above: Photo 4
Jackshaft and Parts Layout

Modified Parts
Each outboard bushing mount plate is also part of the chain tensioning assembly. Mount a 4" section of 1/4-20 threaded rod (Redi-bolt) to the flat edge of the plate. If you weld it, remove the bushing or it may jam or distort, becoming useless for anything except junk sculpture.

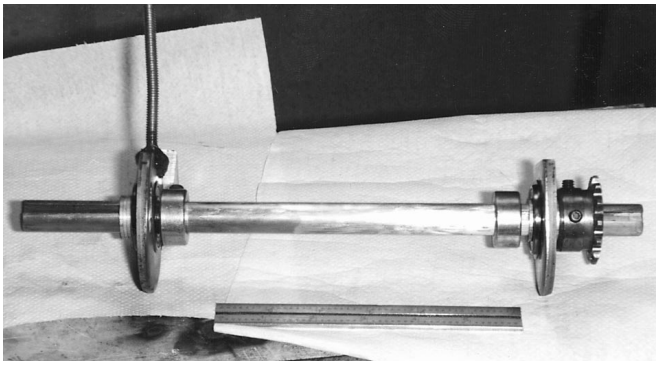
Parts List
Refer to Photo 4 again. From top to bottom and left to right, we have:

1. Outboard bushing plate with 5/8"bushing .
2. Outboard U-mount plate
3. Inboard U-mount plate
4. 5/8" diameter spacer
5. Inboard bushing plate
6. Drive sprocket 3/16" key (Cut from key stock)
7. Drive sprocket
8. 5/8" diameter spacers, (3) (same item as in 4.)
9. 5/8" shaft collar, (2)
10. 5/8" spacers, (2)
11. 10 inch, 5/8" diameter pulley
12. Keys (Cut from 3/16" key stock) 4 needed
13. 5/8" jackshaft with milled keyways for 3/16" key
14. 1/4-28 X 1" capscrews or bolts with flat washers, lockwashers and nuts (8) (not shown in photo)
15. Chain tensioner bridge

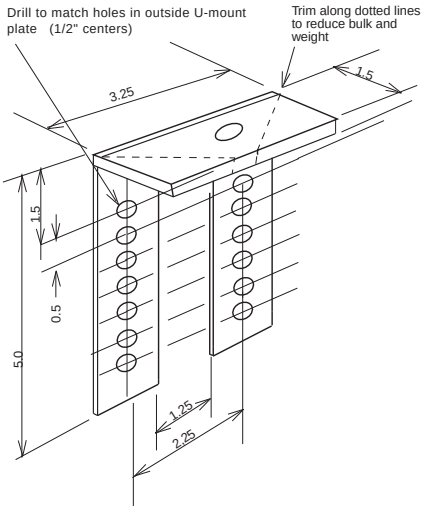
The jackshaft still has one bushing. (Yes, it jammed. I goof up too.)

Attacking Entropy (Assembly Instructions)
Do the left-side jackshaft first. Back the setscews out of the shaft collars. The shaft and inside of the collars must be clean and free of metal shavings or burrs.

Using Photo 5 as a reference, slide components onto the shaft in the following right-to-left order: three



Left: Photo 5
Bare Jackshaft
Assembly



Right: Chain
Tensioner
Bridge,
1/8" Thick
steel

spacers, outboard bushing mount plate with bushing, and shaft collar (don't tighten yet). Shove 'em all the way to the left, then leave a length of free shaft and mount another shaft collar, one spacer, the inboard bushing mount plate and another spacer. Set the assembly aside on a clean cloth.

The right side jackshaft assembly is a mirror image of the left. Put it together and lay it beside its twin.

Place each U-mount plate against the mounting flanges on the frame, clamp, centerpunch and drill through for 1/4-28 X 1" allen-head capscrews. The shorter inboard plate goes to the inside of the supporting frame member while the longer outboard plate bolts outside (Refer to Photo 3).

Holding each jackshaft assembly level (so that the parts don't slide off), mount it in the U-plate supports. Using 1/4-28 nuts, flat washers and lockwashers, bolt through the third hole from the top on both sides of the U-mount plate and the slots in the bushing mount plate. Tighten only enough to hold the assembly together. Mount both jackshafts.

Add the chain tensioner bridge to each side. This square U-shaped piece fits behind the outboard bushing mount plate and the outboard U-mount (refer to Photo 3 again). With the inboard U-mount and bushing plate still fastened, remove the bolts on the outboard end. Slip the chain tensioner into place. The upright threaded rod feeds through the hole in the chain tensioner bridge (see Photo 3). Holes in the chain tensioner legs should line up with the same holes in the U-mount and slots in the bushing mount plate. Put the bolts through all three and re-tighten nuts. Thread two nuts, an adjustment nut and a jam nut, onto each tensioner rod.

Now install the sprockets and pulleys. For each one, place a 3/16" key into the milled keyway. Line up the key slot in the hub and slide the part on. Position the setscrew over the key and tighten, then tighten any other setscrew in the part. When it matches Photo 3, tighten the setscrews. The jackshafts should turn freely, with minimal side-to-side slip.

Access

Author: Clare Bell 271 Molina Dr. Santa Cruz, CA 95060. (408)469-9185. For detailed instructions and fabrication drawings, send $5. HP can't print them all.

Northern Hydraulics 800-533-5545 • fax 612-894-0083

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Electric Conversion Safety Nets

Shari Prange

One of the hottest electric vehicle topics today is safety. The major manufacturers contend that home-built conversions are inherently unsafe. The truth is that home-built conversions—and even commercial conversions—can range over a broad spectrum, from very safe to potential disaster.

Of course, it is in our own personal interests to make the vehicles we drive as safe as possible. Nevertheless, some people routinely risk their own skins by reckless behavior. We cannot rely on a sense of self-preservation to insure safety in conversions.

It is also in our best interests as an industry to promote safety. One spectacular accident would do irreparable harm to our cause. Therefore, those of us in the industry have an obligation to ourselves and to the public to build multiple layers of safety nets into the conversion process, so that a user error will result only in an inconvenience, not a catastrophe.

Above: A universal kit gives you a solid foundation of compatible quality components for the drive system.

I would like to walk through the spectrum of conversion options, from pre-fabricated to home-built, and look at ways to maximize your safety nets at each level.

A Firm Foundation of Expertise

The ideal situation for a home mechanic is building a conversion from a professionally designed kit. The more complete the kit is, the better. This means that someone with more experience has already made design decisions to enhance safety and minimize risk. The home mechanic has the benefit of expertise outside his (or her) own area.

The kit will also have been installed by many other home mechanics previously. Each installation provides one more safety and reliability test, one more opportunity for the kit supplier to discover ways to improve the kit.

Just Add Batteries

A complete custom bolt-in kit gives the opportunity to experience the pleasure of building the conversion, without having to spend all the time designing and fabricating parts, and without worrying about whether the wiring is exactly right. Someone else has already done the design worrying for you. All you have to do is follow the instructions carefully. Because a custom bolt-in kit is pre-designed and fabricated, it is quicker and easier to install. On the other hand, it is also more expensive, since you are paying for that design and fabrication work. Such a kit will cost between $7,000 –$9,000 dollars, and can be installed in about a month of weekends.

Some Assembly Required

A universal kit allows the more adventurous builder to express creativity in the overall design and fabrication of mounts. However, there is still a substantial safety net in the collection of quality components that were factory built and tested, and are known to be compatible with each other.

This kind of kit trades a lower cost in dollars for a higher cost in time. It will cost between $4,000–$5,000, and will require at least 200 hours to install. Of course, ideal situations don't always exist. Not everyone can afford a kit. There are ways to economize and still maintain some of those safety nets.

Copy The Best

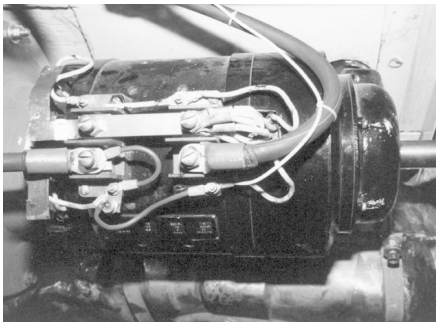
First, choose a good quality kit and use its list of components as a template. If the kit has a main contactor, you should have a main contactor, etc. It's in the kit for a reason. If you leave it out, you have cut loose one of your safety nets.

A small thing like a fusible link can make a big difference. Mike Brown, of Electro Automotive, has had

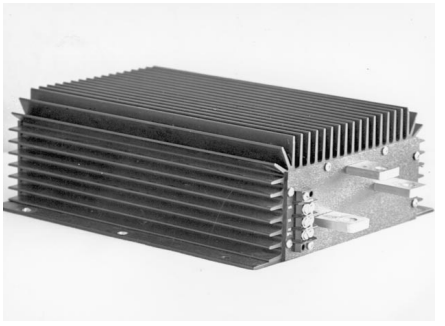
Top left: It's poor economy to leave out safety interconnects, like a main contactor (left), circuit breaker (right), or fusible link (center)

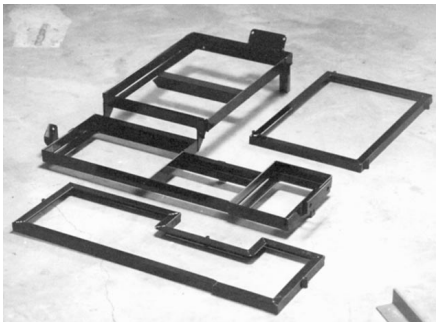
Top center: An aircraft starter or generator like this is not an acceptable subsitute for a real motor.

Top right: An older model controller can still be a quality component with relatively modern technology inside.



Above: An older model charger is heavy and bulky, but it will do the job.





Above: A custom kit will save you the trouble of designing and building key components like battery racks.

the opportunity to test this. While working on a car, he disconnected a cable. It slipped from his hands, contacted a terminal on the controller, and proceeded to try to weld itself into place. As he reached for the shears to cut the cable, the fusible link in the battery pack did its job and blew.

If that can happen to a conversion expert with 16 years of experience, it can certainly happen to you.

Economical Quality Vs. Cheap Junk

Next, look for less expensive quality substitutes for the big ticket items. The key concept here is "quality". An aircraft generator is not a quality substitute for an Advanced D.C. motor, but a used Prestolite or G.E. motor would be acceptable. Series/parallel switching is not a quality substitute for a MOSFET controller, but an older PMC transistorized controller, or even a good SCR might be acceptable. An older Lester charger is bulky, but it will work for you.

By careful shopping, you may be able to pick up used parts from other EV owners who have upgraded their vehicles. These parts will be a generation or two behind the state of the art, and they won't give you optimum performance, but they can still give you satisfactory service for your needs. The price savings may make the difference between being able to have an EV and not being able to have one. Once you have the conversion, you can always upgrade these parts one at a time, if finances allow.

Some of the smaller items, like circuit breakers, are not as likely to be available used, but you might save enough on big ticket items to be able to buy these new.

The trick to making this technique work is doing your homework thoroughly, in advance. You need to know enough about the history of various types of components to separate the wheat from the chaff and shop smart.

Penny Wise, Pound Foolish

The risks increase when you start cutting corners on the component list, or on quality. Saving a hundred dollars by leaving out the main contactor is a poor bargain if your house burns down while you're charging your car. Saving bucks by using a lower quality component (as opposed to a quality component that is simply an older model) is not a savings if your car burns to the ground. These things have happened.

Working Without A Net

The risks multiply exponentially when you start building major components yourself, such as motors, controllers, adaptors, and chargers. Commercially built units must meet strict tolerances, and have multiple safety features built-in. These include things like internal circuit breakers and fuses, and internal

protections against overheating, overamperage, overvoltage, undervoltage, and unexpected acceleration.

You may build these components, and have them function just fine. You may be lucky enough that you never encounter the exact combination of circumstances that will cause a catastrophic failure.

Then again, your luck may run out. With safety nets in place, you'll be calling your supplier to find out why your car doesn't work. Without them, you'll be calling 911.

Building Your Own Nets

These remarks are all intended for the home mechanic building his or her own conversion. There is a big difference between a home mechanic and an independent inventor. Many of the advances in EVs have come from independent inventors. These are people with the skills and resources to develop an idea into a component that can be manufactured, marketed, and used reliably in large numbers.

An inventor has to build his own safety nets. He must use safe established procedures and design techniques. He must also be wise enough to know how much he doesn't know. If his expertise is in electronics, he should consult with someone who has professional automotive expertise. An electric car is electric, and it's a car. To take either aspect lightly is to invite disaster.

Don't Worry, I'll Catch You

If the inventor supplies his creations to other people to install in their cars, he assumes the awesome responsibility of providing the safety nets for the end user. It is not enough for the component to work in one car, under one set of circumstances. The inventor must try to anticipate any way the component may possibly fail from misinstallation, misuse, heat, vibration, dust, water, or other causes. Then he must build in safeguards to make sure it will fail in a safe mode.

Sustainable Alternatives

As EV builders, we are all pioneers, but that doesn't mean we have to be daredevils. Our goal is to build a durable bridge across a canyon into new territory—not to leap across the canyon on a motorcycle. The first provides practical transportation for a great many people. The other is an individual performing a flashy—but useless and dangerous—stunt. When you build your electric car, be sure you build a bridge. And until the bridge is finished, leave the safety nets in place.

Access

Shari Prange, ElectroAutomotive, PO Box 113, Felton, CA 95018 • 408-429-1989

Just Doing My Part

David M. Knapp

Above: David Knapp shows off his PV-powered cordless Ryobi mower and a freshly cut lawn.

When you live in a subdivision, lawn care is one of those items that you do side-by-side with your neighbors. Saturday afternoon includes harvesting a crop that never goes to market and using noisy tractors built for the owner's comfort.

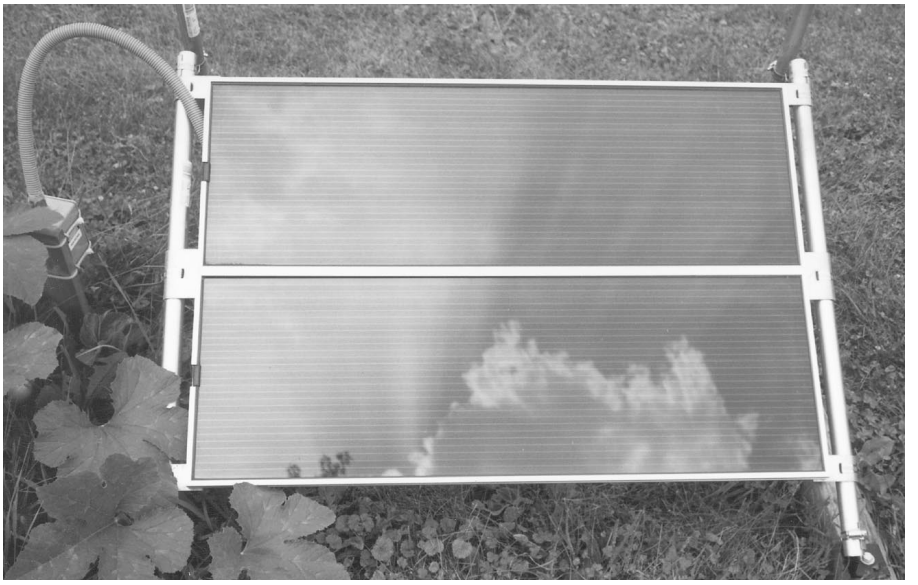
A Breath of Fresh Air

When it came time to replace our lawn mower, I remembered the poster, "Think Globally, Act Locally." I recycled my old lawn mower by giving it to my brother who was starting a landscaping business. I purchased a Ryobi 24 Volt DC cordless mulching lawn mower called the "Mulchinator."

The mower contains a 24 Volt DC motor that spins the blade at 3250 rpm. A circuit breaker serves as a key; one of the many safety controls. Electrical storage comes from two 12-Volt, 12 Ampere-Hour, sealed, lead-acid batteries. Battery bank recharge takes 16 hours using the highly efficient on-board charger. The owner's manual directs the user to leave the mower plugged in all of the time. The charger will go into float mode when the battery bank is full.

Solarize It!

Keeping in mind my future off-the-grid plans, I concluded this mower could easily be PV recharged. The on-board charger charges the batteries up to 30.0 Volts and then goes into the float mode at 29.0 Volts. To make this project affordable I purchased two amorphous solar panels from Real Goods. The 12 Watt, 12 Volt panels make a 24 Volt array. Their peak power was at 14.5 Volts at 930 milliamps. When you put two of them in series you have 29.0 Volts at peak power (the float charge voltage of the on-board charger).



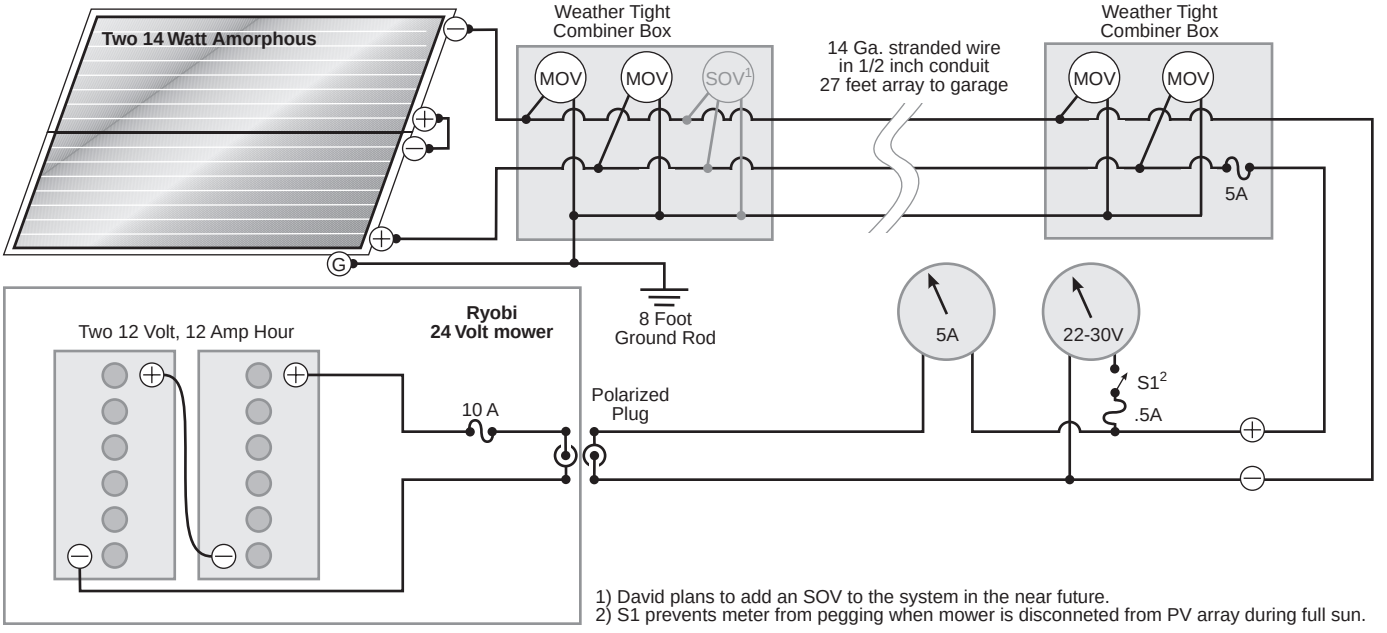
Above: Two 14 watt amorphous panels wired in series provide the charge.

Since the C/10 charging rate of the battery bank is 1.2 Amperes, the panels are perfectly safe to leave connected to the batteries for a week without using a charge controller. Our average summer time sun is about 5.6 hours in the Midwest (4.3 hours per day yearly average). The panel array charges the battery bank in about 2 1/2 days of full sun.

The mower operates for about 90 minutes per charge and has had no trouble mulching my 1/3 acre lawn (which includes a 1,100 square foot house, two-car garage, and 1,000 square foot garden). The batteries should easily last 150 cycles at 50% discharge. The owner's manual recommends sharpening the blade several times a year. A sharp blade will cut through the grass more easily and save the batteries.

Installation

Illinois state law says you must call the utility before digging. They will come out and mark your utility connections before you drive that eight foot ground rod into who knows what. After waiting 48 hours for the utilities to be marked, I installed the panels out by the garden about 27 feet away from the garage. The array mounts on a Zomeworks Pipe Tabs kit and 14 feet of 1 inch OD conduit. The PV rack sits on 2 four-foot landscaping posts for stability. One half-inch conduit carries the 14 gage wire into the garage. An analog voltmeter and ammeter provide for general indication of electrical wellness.



1) David plans to add an SOV to the system in the near future.
2) S1 prevents meter from pegging when mower is disconneted from PV array during full sun.

Above: The charging station in David's garage.

A polarized jack and plug make a quick release connector for solar-charging (less than 1 Amp). I use automotive DC type five or ten-amp fuses at the battery bank and in the wall box in the garage. I use a total of four MOVs in order to provide lightning protection from transient high voltage surges.

If I Had to Do It Over

Given the opportunity to do it over, I would have purchased the lawn mower years earlier. Although the old mower collected a lot of grass clippings for the compost pile, it's great not to do oil changes or tune ups. My grass is much thicker and has never looked so healthy. It looks every bit as good as some of the neighbors who go through the cut, water, and fertilize routine every week. I also get to hear the birds chirp while I am cutting away.

If I had to buy the panels again I would buy a pair of 10 watt single crystal silicon modules for about 40% more cost. Then I would need to add a small charge controller to the setup. My current panels work just fine. If they have a fifty percent reduction in power within five years, I will still be charging okay. In the winter time, I am sure I will find a use for the surplus power.

The Big Picture

My system inspired two more purchases by friends at work. I am glad to see less pollution as a result of my preaching to peers. As unglamorous as a lawn mower may actually seem, it is a unique feeling to know the same energy that makes your grass grow is also being used to trim its length. Although I would like to convert 100% of my yard to garden space, urban living seems to be home to the "lawn meisters." I have not fallen into the "my lawn mower is bigger than yours" syndrome.

The Future

We have been using our current residence as a sort of training facility to "cut our teeth on." Since picking up our first *Home Power* magazine in 1991, we have reduced our monthly power consumption from 775 KWH to 214 KWH. We have dumped all of our phantom loads, have been slowly replacing major appliances with energy efficient ones, and have converted to compact fluorescents. Our Staber 2300 washing machine and Peerless Premier gas cookstove have been wonderful additions to our new way of life. Next year will yield a new gas dryer to use when it's too cold for the clothes line.

Our next lawn will be only a tiny part of our new homestead. Our solar-powered lawn mower will fit in nicely by mowing a path through the wild flowers up on the roof of our future solar and wind powered Davis Cave earth-sheltered home.

Access

Author: David & Sheila Knapp, 208 N. Church St., Winnebago, IL 61088.

PV mounting hardware and meters: Alternative Power Renewable Energy Center, 701 S. Main, Westby, WI 54667 • 608-634-2984.

PV Modules: Real Goods, 555 Leslie St., Ukiah CA 95482 • 800-762-7325.

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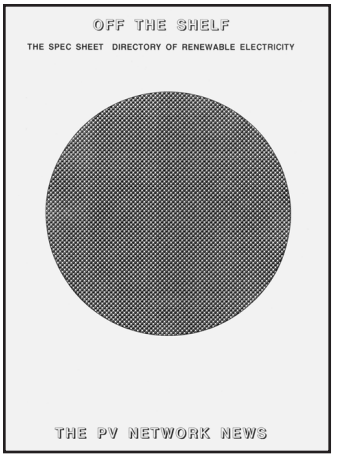
Good Books

Off The Shelf

The Spec Sheet Directory of Renewable Electricity

Compiled by Paul Wilkins

Reviewed by Richard Perez



Ever get into designing a solar electric system and need specific information about a product. Well, you can write the manufacturers for all their product literature—or you can get a copy of Off The Shelf. This book is the answer for designers of renewable energy systems. It is a compilation of product specification sheets for just about every manufacturer in the RE industry. Sections in this book include: photovoltaics, mounts & trackers, batteries, inverters, controls & regulators, small hydroelectric turbines, wind generators, DC lighting (indoor & outdoor), tools, venting, water pumping, and an appendix listing hundreds of dealers and installers of RE products. Whew!

All this renewable energy product information is collected into a 8.5 inch by 11 inch three ring binder containing well over 200 pages. I use it regularly to find out product information such as what is the rated power (or mounting hole dimensions) of a particular PV module, or maybe the surge capacity of an inverter. The binder even includes little extras such as a computer disk demonstrating the OmniLink metering software by SunSelector. Having all the information for all these different products in one place makes it easier to decide which PV module, wind generator, or whatever to use. Having the physical dimensions of all the different products makes designing the inverter/control/battery room or the PV racks much easier.

Over the last fifteen years Paul Wilkins has done much to foster the use of renewable energy. His *PV Network News* has provided access worldwide to RE businesses and services. The Off The Shelf book is his best idea yet. The cost of Off The Shelf is $69.95 shipped prepaid (via book rate) inside USA. For international orders or fast shipping call or write Paul Wilkins.

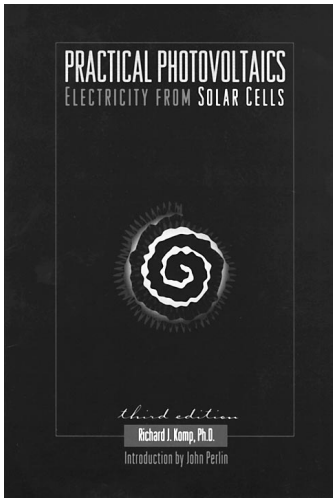
Access

Paul Wilkins, The PV Network News, 2303 Cedros Circle, Santa Fe, NM 87505 • Phone and FAX 505-473-1067 • Internet E-Mail: pvpaulset@aol.com

Practical Photovoltaics

By Richard J. Komp, Ph.D.

Reviewed by Michael Welch



This book has a little bit of everything. At 196 pages, it would be hard to get it all in, and quite frankly, each section of the book left me with as many additional questions as it answered. Fortunately, the author included a reading list at the end of each chapter to fill in the blanks. One might need to end up with an awful lot of reference books, though.

I'm a generalist. This book is good for folks like me that want knowledge without getting deep into the technical stuff. It covers the basics of everything from the history of solar electricity to new developments in PV technology and from how solar cells are made to how they work. It even has an appendix on making a PV module from individual cells.

My favorite part was the chapter on how solar cells are made. It was interesting to learn about techniques for

growing silicon crystals, the construction of the cells, and about the differences between single crystal, polycrystalline and amorphous silicon.

The chapter on how cells work was pretty good, but maybe a level higher than the rest of the book. A knowledge of chemistry and physics would definitely make the section easier to understand.

The chapter on how to size and install systems was informational, but there is a wealth of knowledge out there that is more complete and up-to-date. The same goes for the section on storage of solar electricity.

At $18.95 Komp's 6" X 9" paperback has over ninety illustrations and photos, though many of the photos seem dated... like the photo of the guy in a seventies hair style manufacturing ARCO modules.

I recommend this book for folks that are just learning about PV, but with the warning that this is definitely not a book that can be titled "The Complete Book of Photovoltaics."

Access
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Writing for *Home Power* Magazine

Home Power is a user's technical journal. We specialize in hands-on, practical information about small scale, renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Here are some guidelines for getting your RE experiences printed in *Home Power*.

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Please include all the details! Be specific! We are less interested in general information, than in specific information. Write from your direct experience — *Home Power* is hands-on! We like our articles to be detailed enough so that a reader can actually apply the information. Please include full access data for the makers of equipment mentioned in your article. *Home Power* readers are doers. They want access data for the devices and products you mention in your article.

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Home Power articles can be between 350 and 5,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences that are short (less than fifteen words) and to the point. We like the generous use of Sub-Headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in Home Power. After you've studied a few, you will get the feeling of our style. Please send a double spaced, typewritten copy if possible. If not, please print.

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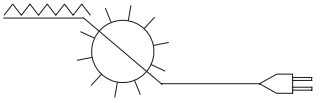

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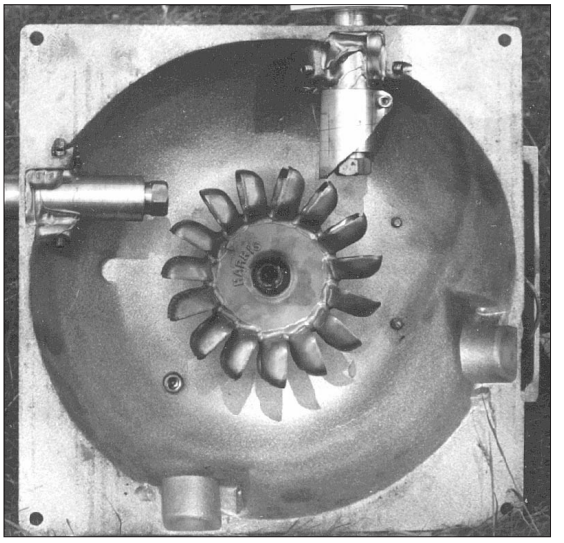

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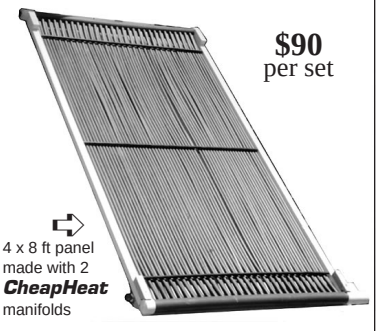

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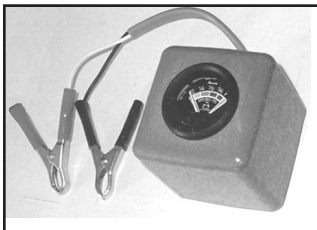

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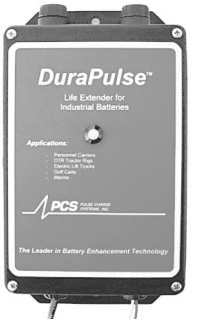

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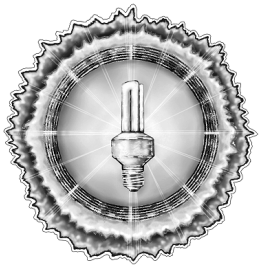

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Independent Power Providers

Don Loweburg

The California PV for Utilities (PV4U) group has recycled itself into the California PV Collaborative. It has also expanded its commercialization efforts to embrace all potential PV markets. The Collaborative will continue to work closely with utilities but now will also work toward developing other market areas. These will include residential end users, institutional users, (California State facilities for example) and commercial applications such as communication services. Work groups have been formed to address both barriers and incentives to the further commercialization of PV. Sub groups are focussing on financing, technical standards, installation standards, public relations and information, rate based incentives, and net metering.

It's the Law

The California net metering law goes into effect January 1, 1996. There are details of implementation that remain to be worked out. Many questions remain about installation requirements and homeowner's responsibilities. IPP and the Collaborative will be fully engaged in these details to make sure they in no way obstruct the clear intention of the law.

Getting the Dough

We need more information from other areas on how people are financing PV homes. How is it happening? Home Power readers can help provide this important information by telling your success stories. In California, the Bank of Willits and others have been making loans on PV homes. IPP wants to build a database of financing information. Please share, this is very important information. Our industry is sort of stuck at the moment with a chicken-egg situation. Banks will loan if they know of other similar successful situations. In many parts of the country a qualified borrower will approach their local bank for financing. The bank will try to seek out comparable sales of properties (PV-powered) in the local area. If they find none the bank will not make the loan. Our goal is to have information available about successful PV lenders and borrowers for all areas of the country. This information would be made available to the banking and lending community and loan seekers. So, please contact IPP by phone, letter or e-mail. Working together makes us strong.

Muchos Gracias

Thank you to all the financial contributors to IPP. The money is very welcome. As you could guess, there is no paid staff here but we do need travel money to attend meetings both in and out of state. IPP membership continues to grow. We have over 120 members nationwide. More important than just the numbers, is the fact that our members tend to be very active and in the front lines of the PV world. This issue we thank IPP member Paul Wilkins for his efforts. Paul publishes the *PV Network News*, a national guide to PV distributors, manufacturers, and dealers in Santa Fe, New Mexico (see Access). He has been researching the activities of a recently formed group called the Photovoltaic Services Network (PSN).

Yet Another Utility Subsidy?

The PSN mission statement declares, "The PSN is an independent, not for profit organization of electric utilities. The original PSN members recognized a need for professional assistance in PV education and training and a forum for off-grid PV application issues. They also recognized a need for high quality packaged PV systems that meet utility standards for performance and reliability. To address these needs, several rural

electric cooperatives joined together to form the PSN, an organization that makes quality PV support services and products available to all their electric utility members."

Paul poses the following questions: "Why does an organization funded by the Department of Energy want to keep the existing distributor-dealer network from selling to the utilities? Why is this organization attempting to be the middleman between manufacturers and utilities? Why does this organization want off-grid systems to be supplied by the utility, when there are local dealers, many who have been around for years developing this market?. These are the same utilities that have fought renewables for years, now they want in the remote home and pumping markets?"

Paul continues, "It seems that PV Services Network is going to manufacturers and trying to arrange bulk buys on products to resell to the utilities. They also sent a form around asking companies if they would like to supply the PSN PV water pumping or remote residential systems."

They Say

Kirk Stokes, manager of PSN, replies, "First the PSN does not intend to 'go around' existing distributors (we call them system suppliers) that provide us with high quality packaged systems at competitive prices. We intend to purchase packaged PV systems for off-grid applications (water pumping and residential initially) from qualified system suppliers. The PSN will not be a system integrator nor will it carry any inventory. The PSN will essentially be a purchasing agent on behalf of its utility members and will purchase only from system suppliers." (we assume he means not buying directly from individual component manufacturers.)

"Second, in the majority of the PSN's member utility service areas (24 of our 32 utility members are rural electric cooperatives that serve communities in 12 western states) there are no existing PV dealers! There are not PV dealers because there has been no PV market in these rural communities! However, the fact is that there are niche markets for PV within these communities and the local 'member-owned' utility can facilitate the development of that market. Also, these electric cooperatives will depend heavily on local contractors (electricians, well service technicians, etc.) that add PV to their businesses as the local market develops."

"In this capacity, I believe that the PSN is helping to create new PV market niches where none exist today by encouraging the involvement of these rural electric cooperatives and the local trade allies. The PSN and these utilities are not going to take away your early adopting consumers who may not want the local utility involved anyway. We believe that we are developing a market network to a new and broader customer base that will be happy that the local utility is involved."

We Say

IPP, like Paul, is concerned with protecting and developing the private dealer network. We are opposed to federal subsidies that aid investor owned utilities (profit making monopolies) entry into the competitive PV market. In the case of rural cooperatives (member owned utilities) we don't have the same anti-competitive issues, but we still question the role of subsidies. Do they really develop the market? When the subsidy goes, what happens? Most often the agencies close up shop, leaving a few systems in place, a few years of nice paychecks for some administrator but no dynamic market in place. IPP members have already taken risks, put their own capital and sweat on the line and have begun to develop a competitive market for PV services and systems. This dynamic market is the future for PV and renewables. When all sectors of the PV industry better realize this, the commercialization of PV will truly accelerate.

Coming Features

Next issue we plan to have some first hand reports of what Idaho Power is up to. I have said this before, but want to re-emphasize, we seek input from IPP members from all parts of the country. This is a national organization dealing with national energy policy issues. Recently the Utility Photovoltaic Group (UPVG), a national consortium of mainly investor owned utilities, announced increased interest in small scale PV applications (off-grid). They characterized this market as "significantly" bigger than had been expected. This marks a significant turn around from two years ago when off-grid was characterized as a niche market. Now the utilities admit their intentions to pursue this market in a major way. IPP objected then because PV represented a competitive alternative to utility service. Nothing has changed except that now the utilities are out front with their plans.

IPP and Solar Energy International (SEI) are planning to offer a hands on course for installers. The program would issue an IPP certificate for successful completion. Participants would be encouraged to also complete an electrical contractors program in their own state. We believe this will help develop the PV infrastructure and increase the credibility of the industry. As now planned an off-grid program will be available this coming summer

Access
Author: Don Loweburg, IPP, PO Box 231 North Fork, CA 93643, 209 877 7080, • i2p@aol.com

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Please check with your public library before sending them a sub. Some rural libraries may not have space, so check with your librarian before adopting your local public library. Sorry, private or corporate libraries are not eligible for this Adopt a Library deal—the library must give free public access. — Richard Perez

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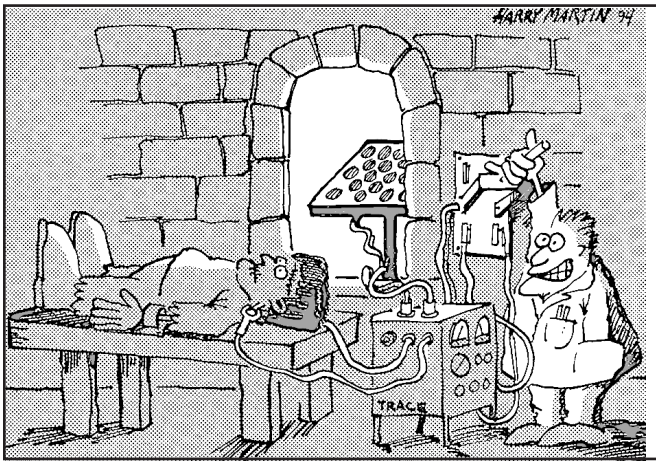

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Designing PV Systems to Meet the National Electrical Code

John Wiles

Thinking about a new PV system or an update to the old system? Got an electrical inspector driving by the homestead once a week and wondering what's going on? Thinking about upgrading the safety of the system for those times when the non-technical spouse and kids are home alone? If so, then pull up a chair and let's talk codes and PV systems. With this Code Corner, we start the full cycle of how to design and install a PV system that will meet the National Electrical Code (NEC).

Systems that are designed and installed in a manner that will meet the NEC are usually safer to operate and maintain than those systems that do not meet the NEC. They also are usually more durable and reliable.

Although the system requirements described in these columns will be based on the 1993/1996 National Electrical Code, anyone installing PV systems should be aware that there are local codes that supplement the NEC and that the electrical inspector has the final say on what is acceptable.

System Design—Sizing

PV system sizing is outside the scope of this column, and the information that follows here and in successive columns will assume that the basic PV system has been sized. Most of the PV module manufacturers have sizing programs that are used by the dealers and distributors to assist in determining the size of the PV array, the battery bank, the generator, and other components. The size of the system is usually based on either the required electrical loads or available funds.

If a do-it-yourself approach is desired, then back issues of *Home Power Magazine* provide much useful information, and there are several books (see advertisements in *HP*) that have good design information. Sandia National Laboratories has a Stand-Alone PV Design Manual available for the professional (See access).

After the system is sized, the PV modules, the battery bank, the inverter, and the charge controller are selected. The use of components that are listed to the standards established by Underwriters Laboratories (UL) will ensure that these components have passed rigorous electrical compatibility, electrical shock, and fire safety tests. The use of listed components will make for greater compliance with the NEC requirements and allow the system to pass electrical inspections more readily.

It is now time to design the balance of system (BOS) and select the various cables, switches, overcurrent devices, and other items that will connect the main components. Careful attention to the BOS design process will result in a system that is safe, durable, reliable, and meets the NEC. The following sections will outline the general BOS design considerations. Subsequent Code Corner columns will provide detailed information on each area in the PV system.

PV Module and Source-Circuit Wiring

The selected PV system voltage (12, 24, 48, or ?) and the total number of modules will determine the number of modules connected in series and parallel. The name plate rating (marked on the back of each module) will give the open-circuit voltage and short-circuit currents of each module. These numbers will be used to determine the size of the module interconnect cables and the size of the cables from the inverter to the charge controller or power center.

The types of cables used and the insulation on them will be determined by how they are to be mounted. The NEC allows exposed single-conductor cables between the modules. Several other wiring methods are also allowed between the modules and from the modules to the power center. Multiple conductor, sheathed cables and single cables in plastic and metal conduit are frequently used. Since the cables are used in an area exposed to the outdoors, cables rated for wet environments are required.

The PV module operates at temperatures that can be

20-40°C above the ambient temperature. All PV modules should be wired with cable rated at 90°C. The ampacity (current carrying capacity) must be derated for these high operating temperatures.

Since most fuses and circuit breakers are designed to use cables with 75°C insulations, some cross checking must be done to ensure that the 90°C cables are not operating at a temperature higher than 75°C.

In very cold climates, the PV module can operate at temperatures below 25°C, and these low temperatures increase the open-circuit voltage of the system. Calculations must be made to determine the maximum open-circuit voltage so that the voltage rating of the cable, fuse, or circuit breaker is not exceeded.

Battery and Battery-to-Inverter Wiring

In stand-alone systems with battery banks and inverters, the cables between these two devices usually carry the highest currents in the system. These are single-conductor cables that are installed in conduit between the battery and the inverter and a power center or DC load center. Inverter input current must be calculated so that these cables can be properly sized. Building-wire type cables should be used. Inspectors are looking closely at systems to ensure that welding cables and automotive battery cables are not being used.

Grounding

There are two types of grounding—equipment grounding and system grounding. All renewable energy systems that have exposed metal surfaces (module frames, mounting racks, enclosures, inverter and charge controller chassis, pumps, etc.) must have those exposed metal surfaces grounded by connecting them to a ground rod (eight feet long of copper or copper coated steel). This equipment grounding requirement applies to all systems (even 12-volt) unless they are listed as double insulated and have no exposed metal surfaces—at this time, there are no such systems.

System grounding refers to the connection of one of the current-carrying conductors to the ground rod at one and only one location in the system. This is optional for 12-volt systems, but required for any higher voltage system. In most systems, the negative conductor is grounded; the rare exception is a PV system supplying a telephone system, which usually requires a positive ground.

Grounding also affects the ability of the system to reject the effects of nearby lightning strikes.

Load Circuit Wiring

All wiring to both ac and DC load circuits should have three conductors. In the DC circuits, these are the positive, the negative (usually the grounded conductor), and the equipment ground. In the ac wiring, these are the hot, the neutral (the grounded conductor), and the equipment ground. All connecting sockets must have provisions for three conductors. While there are some listed, double-insulated ac devices that can use two-prong plugs, most DC equipment is not so listed and must have the equipment grounding conductor in the attached cord and plug. These DC appliances should have the exposed metal surfaces connected to the equipment grounding conductor.

Two-conductor automotive cigar-lighter plugs and sockets do not meet NEC requirements and are usually not durable or safe.

Overcurrent and Disconnect Devices

Each ungrounded conductor in the system should be protected by an overcurrent device (fuse or circuit breaker). The array, the battery, other renewable energy sources, and the generator or the grid are sources of potentially hazardous currents. If the option of an ungrounded system (12 volts only) is elected, then overcurrent devices must be installed in both of the (now) ungrounded conductors.

Disconnects are required so that all sources of energy (PV, battery, generator, and grid) can be disconnected from the system. Disconnect switches are also required to isolate equipment (charge controllers and inverters) and fuses for servicing. Like overcurrent devices, disconnect switches are required in ungrounded conductors; and in an ungrounded system, two-pole disconnects are required—one pole in each of the ungrounded conductors.

Enclosures

Since the system must have disconnect and overcurrent protection for the battery to inverter cables and for the charge controller to battery to array cables, then one or more enclosures must be used to house the necessary devices. In some cases an all-in-one power center is used, and in other installations several separate enclosures are used. These enclosures should be standard, listed electrical equipment enclosures. They may be either metal or PVC and should have provisions for the necessary conduit fittings.

Batteries must be mounted in some sort of enclosure (preferably non-metallic) to keep the terminals from being exposed and to provide some containment for spilled electrolyte and acid fumes. Adequate ventilation around the batteries is necessary, and they should not be mounted in living areas.

Some charge controllers have appropriate enclosures, complete with knockout fittings. Others without enclosures that have exposed terminals are best mounted in a separate box.

Summary

Designing and installing PV and other renewable energy systems that comply with the National Electrical Code can result in safer, more reliable, and more durable systems. In the next *Home Power* "Code Corner," the NEC requirements for PV module wiring will be covered in great detail.

The author is willing to answer questions on PV design and code issues relating to this and previous Code Corner Columns. Phone, Fax, or write to him at the address below.

Access

Author: John C. Wiles • Southwest Technology Development Institute • New Mexico State University • Box 30001/ Department 3 SOLAR • Las Cruces, NM 88003 • Phone 505-646-6105 • FAX 505-646-3841

1996 NEC and the 1996 NEC Handbook: The National Fire Protection Association • 1 Batterymarch Park • Quincy, MA 02269-9101 • 800 344-3555

Stand-Alone Photovoltaic Systems Design Manual: The PV Design Assistance Center • Sandia National Labs • Mail Stop 753 • P.O. Box 5800 • Albuquerque, NM 87185-0753.

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(Sorry, we're out of issues 1 through 10, #12 , #15 and #36). We are planning to compile them into a book. Until then, borrow from a friend. If you have a computer (or a friend with one) download the article you're missing by calling the Home Power bulletin board at 707-822-8640. Or check with your local library; through interlibrary loan, you can get these back issues. Jackson County Library in Oregon has all issues as does the Alfred Mann Library at Cornell Univ.)

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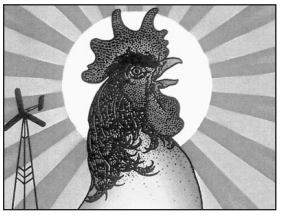


The Midwest Renewable Energy Association Spring Workshop Schedule

MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration.

Membership and participation in the MREA are open and welcome to all interested individuals and organizations.

February 24–25: Energy Efficient Construction Techniques
Instructor: Mark Klein of Gimme Shelter Construction
Location: Amherst, WI Cost: $200
In this workshop you will learn about residential siting and how to incorporate passive and active solar design, daylighting, hydronic heating, energy efficient and environmentally friendly building materials, and super insulation construction methods into your design plans.

March 30–31: Batteries and Inverters
Instructor: Bob-O Schultze of Electron Connection and staff member of Home Power
Location: Tomahawk, WI Cost: $250
Through demonstrations you will learn about batteries and inverters including performance, characteristics, installation, and safety considerations. There will be am emphasis on the Trace 4000 watt sinewave inverter. Basic knowledge of electricity recommended. Includes housing and food for the weekend.

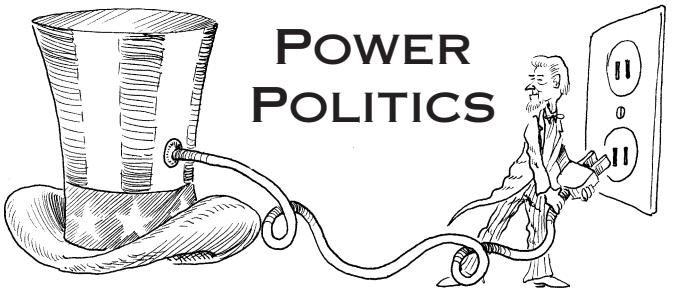
April 13–14: Photovoltaic Systems
Instructor: Jim Kerbel of Photovoltaic Systems
Location: Amherst, WI Cost: $200
This course includes siting, design, and sizing, charge controllers, batteries, inverters, wiring, and installation methods of PV systems.

April 27–28: Solar Domestic Hot Water
Instructor: Chuck Gates of Altech Energy
Location: Forestville, WI Cost: $225
Through hands-on demonstrations and an actual installation of a two panel system you will learn different types and components, siting, sizing, transfer fluids, and controllers for solar hot water systems.

May 4–5: Grid-Intertie Wind Systems
Instructor: Mick Sagrillo of Lake Michigan Wind & Sun
Location: Milwaukee, WI Cost $225
This workshop covers siting, system sizing, installation, zoning, and utility issues. For utility intertie wind systems in the 3 KW to 20 KW range. There will be several site visits of working systems and equipment will be on hand for demonstrations.

Significant others may attend with you for 1/2 price.
Workshop fees cover instruction, handouts and lunch on both days.

For more information call or write
The Midwest Renewable Energy Association
PO Box 249, Amherst, WI 54406
(715) 824-5166 phone (715) 824-5399 fax



Restructuring Utilities & Government

Michael Welch

Ever since the largest electrical consumers in California decided they didn't want to pay the high costs of the state's nuclear-powered electricity, there has been a struggle between factions about restructuring.

California's efforts are an example of what is now happening with utility restructuring everywhere. The battle started there, and what happens there may be repeated throughout the nation.

California's restructuring factions can be divided into several categories, each with its own goals. The utilities have the goals of maximizing their profits and minimizing their losses. Minimizing losses means making sure that they don't have to eat their investments in power plants that are uneconomic to build and operate, i.e. the nuclear ones. Maximizing profits means making sure the utilities have control over the transmission lines that power producers and consumers need for access. They also want their more economically viable power plants to be competitive with other power producers. On a company per company comparison, California's utilities are some of the most politically powerful organizations in the state. You can bet they won't lose much in whatever deal is finalized.

The most powerful faction in the state may be the coalition of manufacturers that started this whole process. They just want cheaper rates, and don't really care about anything else. It is interesting to note that we barely heard from them as the state's nuclear boondoggles were foisted upon the ratepayers. It was only after a few years of increasing rates that they started to complain. Their tactic is to threaten to take their business and jobs to other states unless things change. They also have been successfully using this tactic to reduce business taxes, fight environmental regulation, and minimize worker safety laws.

A faction growing in power across the nation is the independent power producers. They are entrepreneurs and corporations that are building mostly small and mid-sized power plants in areas where the resources they need are plentiful. Usually, those are plants that burn things like wood chips, garbage, tires, rice straw and natural gas. There is a lot of "alternative energy" used by these plants, but very little of it is considered "renewable". The independent power producers' goals include maintaining their market access and making sure that they can continue to economically compete with the larger power producers. Their fear of being left out of utility restructuring has been the impetus to organize solidly and invest in lobbying and influence.

The final faction encompasses those that have a difficult time gaining power and influencing decisions. In general, their goals are societal in nature and aren't the strictly economic goals that accompany wealth and power. They include consumer advocates, environmental groups, social justice organizations, and renewable energy trade organizations. Though their goals are diverse, they are grouped together because they have been stymied in becoming a viable part of the restructuring process. But in California, they have recently banded together to offer alternatives to what the more powerful factions have come up with. They are the true voice of the citizens, environment, and fairness. They represent the public interest.

Last summer, the utilities, manufacturers, and independent power producers got together and produced what is being called a Memorandum of Understanding. The MOU is a back-room deal designed to give those most powerful factions what they want. Public interest organizations that have been involved with California's restructuring efforts from the beginning were intentionally excluded from this process. The saddest part is that the PUC is appearing to embrace the MOU fully.

To the Rescue

These previously excluded organizations are pushing their own proposal in a similar manner to the way the limited-party MOU was presented. The California PUC granted submission of the MOU, gave it an exclusive full-panel hearing, and asked for comments specifically on the MOU. The PUC shakily justified this in response to nothing more than what they called "public speculation" about the existence of the MOU.

The public interest faction, feeling rather left out of the process, decided that if they presented their own proposal in the same way that the MOU was presented, that the PUC should have to treat it the same way, as well. They collaborated on a "Framework for Restructuring in the Public Interest", and presented it in such a way as to obtain the same considerations given to the MOU. Hopefully this tactic will work, but we must keep in mind that California's PUC was politically appointed by Governors well known for favoring business interests over public interests. They may figure out a way to ignore the Framework.

That would be a shame, because the Framework appears far more favorable in scope to anything previously presented. It includes "a better balance between all affected interests and superior resolution of restructuring issues than is achieved by the MOU." The Framework is meant to replace the MOU because it "fails to provide for meaningful, beneficial change for all classes of electric customers and fails to ensure that this state's public policy and public interest goals and laws... will continue to be maintained and improved."

The general principles of the Framework include: electric rates be reduced for all customers, at least part of the losses from uneconomic power generating facilities be born by the utility that decided to invest in the uneconomic plant, the market power of large, investor-owned utilities should not threaten the benefits of utility restructuring, competition and efficiency in the electric market place should be supported, direct access for small customers should be adequately addressed, and low income and minority communities should also benefit from restructuring.

The Framework also gives strong consideration for programs and goals for the environment, renewable resources, and public policy.

The Framework suggests and requests detailed recommendations in all areas. The one most interesting to *Home Power* readers may be a recommendation that all "investor-owned utilities that continue to supply generation shall maintain a supply portfolio with a minimum level of renewable resources consistent with 1993 levels and diversity." And, in order to "increase the level of resource diversity and expand the commercialization of renewable energy technologies, a portion of the system benefits charge shall be allocated to a renewables development fund."

The Framework is a ray of solar hope shining on a bleak landscape. Californians can support it by writing the California PUC (see access).

Restructuring California Government, too

I have often written that the only way to make the politicians pay attention to the people that elected them is to finally do something about election financing and access by lobbyists. This effects renewable energy because some of the biggest offenders are the fossil fuel, nuclear, and automotive industries. Additionally, such reform is necessary to limit political appointments of the sort that have effected California's PUC and the way it favors big business over the consumers.

This situation may soon change. People in California are beginning an initiative process to get political reform on the 1996 ballot. CALPIRG is the sponsor of the effort to make meaningful headway in decreasing the size of donations, where the donations come from, and the kind of access lobbyists have to elected officials.

CALPIRG's efforts have brought forth some interesting statistics for California. 96% of politicians' contributions come from big donors. 90% of their contributions come from outside their district. 70% of California candidates' money comes from PACs and Corporations.

Many state's laws have been ineffective because they were pseudo-reform that didn't really do much, or because there were huge loopholes. The CALPIRG initiative will set strict contributions limits, require candidates to raise at least 75% of their money from their own district, ban gifts from lobbyists, and set strict limits on campaign spending. The measure is modeled after those in Missouri, Montana, and Oregon.

This is a solid step in the right direction. We will still need similar laws passed on the national level. Unfortunately, Congress would have to pass these laws, and it is very difficult to get these entrenched institutions to pass laws to regulate themselves.

Access

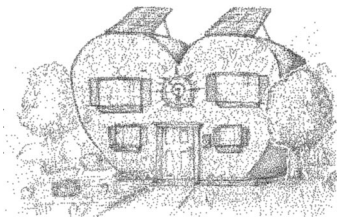
Author: Michael Welch, PO Box 293 Arcata, CA 95518; • E-mail: michael.welch@homepower.org • 707-822-8640 computer BBS • 707-822-7884 .

CALPIRG's Committee Against Political Corruption, 11965 Venice Blvd. #408, Los Angeles, CA 90066 • 310-397-3404 phone • 310-391-0053 fax.

Attorney for the Framework document organizations: Sara Steck Myers 122 28th Ave., San Francisco, CA 94121 • 415-387-1904 phone • 415-387-4708 fax.

Send Comments on California's proposed restructuring "Framework" to: Public Advisor, California PUC, 107 S. Broadway Room 5109, Los Angeles, CA 90012.

Home & Heart



Kathleen Jarschke-Schultze

"O Lord, won't you buy me a
dishwashing machine,
My dog licks each plate twice,
they still don't come clean,
My friends think I'm the biggest slob
they've ever seen,
So, O Lord won't you buy me a
dishwashing machine."

Preparation

When you start looking for an appliance you need to identify all the features that are important to you. In an RE system you need to know the limits of your power system. You'll need to know how to find and read the small, usually metal, information plaque hidden somewhere on the machine.

I am looking for an efficient dishwasher. It has to be a low water user. It doesn't need a water heating element. Our solar water system supplies very hot (150° F) water. It has to work well and be made to last. I don't need a 'garbage disposal' feature as I have a compost/worm box. It has to be efficient in water use. I want an under the-counter-model. It must be so easy to install that I can do it myself. This usually means it must be accompanied by clear, coherent installation instructions.

Crock-a-gleam

One of our readers on the Isle of Man was kind enough to send me a packet of manufacturer's handouts on all kinds of appliances available in Europe. As with washing machines, the Europeans have a much larger choice of very efficient dishwashers. They come in all sizes. Some models are small enough to fit on top of the counter, like Mrs. Rumpole's Crock-a-gleam. Some models are called 'slimline' which are about two thirds the width of a regular machine and yet still hold 12 place settings.

Another interesting difference is that European appliance manufacturers have several models each to choose from. I learned from a saleswoman at a local appliance store that American manufacturers have many models each which change and are discontinued regularly. I explained that I lived on RE and was researching a purchase and would not be buying a dishwasher for at least two months. She said that the models on display might not be available then. Two of the models on the floor had notices that they had been discontinued and the floor models were the last of that line. That kind of makes me wonder about parts availability.

Available Features

Apparently, a really big selling point with dishwashers is how quiet the machine is. From what I could determine, the more you pay the quieter the dishwasher is. The more expensive models had more sound dulling insulation. So you must choose, quietness or cost. In our house the kitchen is open to the living room, Bob-O's office and what we laughingly refer to as the dining room. For us noise level would be a factor. Our clothes washer is loud, but it is in the basement.

The higher priced models also have a high temperature wash option. This is described as 140°F water essential to dissolve greasy food. The interesting thing about this is that most of the models I looked at instructed that 140°F water be introduced to the unit from your hot water line. So what is the power hog heater for? I don't need the high temp feature if my input water is already 150°F. The price just went down.

Adjustable racks are really cool. Be sure to check what the dish racks are covered with. If it is a really good, long lasting coating the manufacturer will usually brag about it in the attached literature. One model I liked had a flat removable silver ware holder in the door. Great use of space and it keeps the silverware well contained so it can't be blasted out of a basket and fall into the spinning water spray arm.

There is also a hot or cool dry option. Obviously I will want to leave the control on cool dry to keep the heater off as much as possible. I have heard from friends who have dishwashers that you can just turn off the machine and open the door at the beginning of the dry cycle and let the dishes air dry. That appeals to me. In my youth I could never convince my mother that air drying dishes was more sanitary than drying with a dish towel.

Requirements

Water pressure from your water system to most of the machines I looked at needed to be between 15 to 120 psi. There are slight differences between manufacturers. Some needed at least 18 psi and some models could tolerate up to 176 psi. Our gravity fed water system pressure is approximately 60 psi at the house. Just about mid range for all the models I saw.

You will need to decide where the machine is going to live, usually right next to the sink. Measure the area and be open to making the adjustment of several inches in width to make your chosen model to fit.

Info Plaques
On every model there is an info plaque that you need to be able to decipher. It will tell you the model number, the serial number, the motor amps, the heater amps and combined total amps. The volts and Hz are also listed, but on every model I looked it was 120v and 60Hz.

model no. 000XX00X000	120V 60Hz	motor 2.6 A heater 5.4 A
Serial no. 1234567890	UL	total current 8.0 A

Formula for Success
You need to multiply the number of amperes by the amount of volts to get the amount of watts used. (See "Back to Basics" in *HP*#29) So if the motor only uses 2.6 amps without using the heater this machine would use 312 watts. (2.6A x120v). With the heater in use the combined 8 amps times 120 volts would equal 960 watts. Quite a difference between the two. Our Trace inverter won't have any problem with this wattage draw.

Water Use
Water use is something American manufacturers don't list with other features or options. I will have to call each manufacturer with specific model numbers to get that information. European models list water usage prominently and even have an Eco-wash option that uses even less water.

Conclusion
I told the saleswoman I will not be choosing a dishwasher soon. There is more homework and studying of the machines available before I decide. Most salespeople are of two minds when you pre-shop. Either they are interested enough in the fact that you live on renewables to try to find the information you need or they write you off as a probable no-sale and leave you to ferret your own information.

Here's some hints if you get left on your own. The info plaque is usually located somewhere on the edge of the open door or door casing. There is usually an installation manual and owner's manual stuffed between the machine and counter top if it is not already in a plastic bag inside the machine itself.

Access
Author: Kathleen Jarschke-Schultze is letting her dishes air-dry at her home in northern-most California, c/o *Home Power Magazine,* POB 520, Ashland, OR 97520 • 916-475-0830 • Internet Email: kathleen.jarschke-schultze@homepower.org or kjs@snowcrest.net

Manufacturers: Whirlpool • 1-800-253-1301, General Electric and Hotpoint • 1-800-626-2000, Jenn-Air • 1-800-536-6247, Roper • 1-800-447-6737, Kelvinator • 1-800-944-9044

HAPPENINGS

CANADA
The "Alberta Sustainable House" is now open for public viewing every Saturday 1:00-4:00 PM free of charge. The first of its kind in Canada, the project emphasizes cold-climate state-of-the-art features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: high effiency windows, multi-purpose masonry heater, solar hot water, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary Alberta T3L 1V9, Canada; 403-239-1882, Fax: 403-547-2671.

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For more info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada; 902-892-9578.

NATIONAL
Energy info on the Internet can now be accessed via the Energy Efficiency and Renewable Energy Network (EREN), a multimedia WWW server developed by the DOE. Check it out at http://www.eren.doe.gov or contact: Energy Efficiency and Renewable Energy Clearinghouse, PO Box 3048, Merrifield, VA 22116; 800-363-3732; e-mail: ENERGYINFO@delphi.com

American Hydrogen Association Bulletin Board System: Solar Hydrogen BBS, 415-494-3116, 1200–14,400 baud V.32bis. V.42bis 8N1; also, Prosperity without Pollution: AHA Tempe BBS 602-894-8403.

Energy Efficiency and Renewable Energy Clearinghouse (EREC) is offering free info on Sunspaces for the homeowner who wants to take advantage of the sun's energy to help warm and brighten their home. Ask for Sunspace Basics (FS124). Also available, Energy Efficient Water Heating (FS204t): Hot water heating alone accounts for nearly 10–30% of an average monthly residential utility bill. Several measures can help you decrease water heating costs in your home. Some specific actions include reducing the amount of hot water used, making your water heating system more efficient, and using off-peak power to heat water. For free copies contact EREC: Phone: 800-DOE-EREC (363-3732); mail: EREC, PO Box 3048, Merrifield, VA 22116; e-mail: energyinfo@delphi.com; TDD: 800-273-2957; BBS: 800-273-2955.

The Learning to Water Wise and Energy Efficient is a program designed for children, grades 4 thru 8 to teach tomorrow's energy consumers wise habits that they can use for many years to come. Not only do teachers and students receive the instructional materials to learn the concepts and principles of conservation, but they also receive the hardware they need to apply what they have learned. The program is sponsored by local utilities or companies that want to make an environmental difference in their community. For information on helping implement the program in your community contact: Sarah Quarante, Energy Technologies Laboratories. 2351 Tenaya Dr, Modesto, CA 95354,, 800-344-3234. fax 209-529-3554.

The U.S. Department of Energy's Office of Building Technologies (OBT) through NREL (National Renewable Energy Laboratory) is offering bulletins describing current research in heating, ventilating and air-conditioning (HVAC) that is being conducted by OBT and its labs.The free bulletins are "Thermally Activated Heat Pumps", which discusses efficient gas-fired heat pump technology that heats and cools buildings without producing CFCs. Also, HBCU Program at Tennessee State University discusses research in alternative refrigerants. Limited quantities of these bulletins are available by contacting NRELs Document Distribution Service at 303-275-4363, fax 303-275-4053 or evanss@tcplink.nrel.gov (e-mail).

ARIZONA
The State of Arizona is now offering a tax credit for installation of all types of solar energy systems. A solar technician certified by the Arizona Department of Commerce must be on each job site. For info contact ARI SEIA; 602-258-3422.

1995 RESNET Conference, December 13-15, 1995, Mountain Shadows Resort, Scottsdale, AZ. For those interested in learning about "real world" applications of home energy ratings and energy efficient mortgages. The Conference will feature leaders from home energy ratings systems, state energy offices, utilities, the housing industry and the mortgage market who will explore and plan how to develop a national market for home energy ratings and energy efficient mortgages. Introductory to advanced round table sessions. All will explore how to effectively transform the housing market through the main-streaming. For more information contact, Steve Baden, RESNET, 13126 Old Seward Hwy, Unit 26, Anchorage, AK 99515, 907-345-1930, fax 907-345-2386

Follow the Sun with SEI. Learn the latest in Passive Solar Building Design and Photovoltaic Technology. SEI is offering a series of workshops in sunny Tucson, AZ. Topics include Solar Water Pumping—Feb. 5–8; Solar Cooking—Feb. 9–11; Solar Home Design—Feb 12–24 (with special weekend workshops on hot water systems and cool towers); PV Design & Installation—Mar. 4–15;and concluding with Advanced PV—Mar. 18–29. Workshops designed for owner-builders, solar career seekers, industry technicians, ranchers, farmers, and those working in less developed nations. Pumping, solar cooking, and PV workshops have a hands-on component. Tours will be included. Can be taken individually or as part of program. For prices, and brochure contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866. Arizona residents may call 520-327-8558. SEI is a non-profit (501(c)3) educational organization. whose goal is to encourage the practical use of renewable energy through education & technical assistance.

ARKANSAS
Sun Life is now conducting "Third Saturday Seminars" on inexpensive building techniques. Their focus is to teach home building from materials that can last a thousand years and cost less than conventional wood-framing. These are hands-on, all-day workshops. Contact Loren at PO Box 453, Hot Springs, AR 71902.

CALIFORNIA
SMUDs Brown Bag Series IX. Bring your lunch and enjoy a free presentation. Oct. 17, Using post-consumer recycled materials,; Nov. 14, Passive solar architecture & residential design; Nov. 28, The four basics; Dec. 12, SMUDs habitat for humanity project. For more information call 916-732-6835.

COLORADO
Solar Energy International (SEI) is offering "hands-on" workshops on the practical use of solar, wind, and water power. The 1996 Renewable Energy Education Program (REEP) features one and two week sessions: Solar Home Design, Environmental Building Technology (straw bale, adobe, rammed earth & natural building); PV Design & Installation, advanced PV; Solar Cooking; Microhydro Systems; and Wind Power. Experienced instructors and industry representatives teach how to build homes and RE systems. Learn in classroom, laboratory and through

field work. The workshop series is for owner-builders, industry technicians, business owners, career seekers and international development workers. The small, intensive and fun workshops may be taken individually or as a comprehensive program. The cost is $450 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

Visit the new National Wind Technology Center operated by the National Renewable Energy Laboratory, just outside of Golden. Facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance, 303-384-6900, Fax 303-384-6901.

MASSACHUSETTS
On March 4–6, 1996 in Boston, MA, NESEA will bring you the results of a 15 nation project to optimize solar electric buildings in a powerful combination with RENEW '96 and the 12th Annual Quality Building Conference. This triple event will bring together forward thinking building and energy professionals to discuss ground breaking research and real world projects in healthy, resource efficient construction, distributed generation and grid scale renewable energy production, transmission and management. For more information contact: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

MICHIGAN
The Fourth Annual EnV'96, "Environmentally Friendly Vehicles Technology & Alternative Fuels" Conference and exposition will be held January 22–23, 1996 in Dearborn, Michigan. The essential forum to discuss the challenges and opportunities for developing and commercializing environmentally efficient vehicles. Industry leaders will address engineering, materials, and alternative fuels issues affecting the redesign of the traditional automobile and its effect on consumer lifestyles. Exhibitors will showcase the latest developments in alternative fuel and energy systems along with evolutionary applications. For registration information call 313-995-4440

NEW YORK
The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516

May 10–17, 1996, the 8th Annual American Tour Sol. Road rally championship for electric and solar cars from New York to Washington, DC. For more information: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

NORTH CAROLINA
SOLAR '96, National Solar Energy Conference, featuring the 25th ASES Annual Conference and the 21st National Passive Solar Conference, April 13–18, 1996, Asheville, NC. For more information contact, American Solar Energy Association, 2400 Central Ave Ste G-1, Boulder, CO 80301

Solar Energy International (SEI) is offering a special one week workshop on PV Design & Installation and a three day Microhydro Systems workshop. Both will be held in Asheville coinciding with Solar '96, the National Solar Energy Conference. The PV workshop will be held the week before Solar '96, April 8–12, and costs $450. The MIcrohydro workshop the week after, April 19–21 and costs $300.Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

OHIO
The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more information contact, Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44 or 614-899-6263, Fax 614-899-1717. Internet address: DUSSAULT@delphi.com

OREGON
University of Oregon, School of Architecture, Eco-Design Arts Conference, April 11–14, 1996, provides an opportunity for environmental designers, artists, planners and the community at large to explore solutions that are ecologically sound, aesthetically fulfilling and indicative of our interdependence. Three days of panels, lectures, workshops related to the creation of regenerative communities, and a professional peer "juried track" spread over four days. A call for papers will be announced soon. For more info, call or write HOPES at: phone; 503-346-0719, e-mail; hopes@gladstone.uoregon.edu

Aprovecho Research Center has three internship openings for Fall term. Interns study organic gardening, sustainable forestry and appropriate technology. Help bring in the seasons crop, do some horse logging, finish testing a new solar thermal pump, desalinator, solar dehydrator and solar refrigerator. Cost is $500 per month, includes room and board, classes 8:30 to 5:30 daily. Contact Aprovecho at 80574 Hazelton Rd., Cottage Grove, OR 97424 or call (503) 942-8198.

TENNESSEE
Bioenergy '96, The Seventh National Bioenergy Conference, September 15–19, 1996 in Nashville, TN. (Geared toward industry and cities) Call for papers, abstract deadline March 1, 1996 For more info contact the host, Southeastern Regional Biomass Energy Program, Tennessee Valley Authority, CEB 3A, PO Box 1010, Muscle Shoals, AL 35662-1010

WASHINGTON DC
May 10–17, 1996, the 8th Annual American Tour Sol. Road rally championship for electric and solar cars from New York to Washington, DC. For more information: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

WISCONSIN
The Midwest Renewable Energy Association Spring Workshop Schedule.

February 24–25: Energy Efficient Construction Techniques, Instructor: Mark Klein of Gimme Shelter Construction, Location: Amherst, WI, Cost: $200—In this workshop you will learn about residential siting and how to incorporate passive and active solar design, daylighting, hydronic heating, energy efficient and environmentally friendly building materials, and super insulation construction methods into your design plans. March 30–31: Batteries and Inverters, Instructor: Bob-o Schultze of Electron Connection and staff member of Home Power, Location: Tomahawk, WI, Cost: $200—Through demonstrations you will learn about batteries and inverters including performance, characteristics, installation, and safety considerations. There will be am emphasis on the Trace 4000 watt sinewave inverter. Basic knowledge of electricity recommended. April 13–14: Photovoltaic Systems, Instructor: Jim Kerbel of Photovoltaic Systems, Location: Amherst, WI, Cost: $200—This course includes siting, design, and sizing, charge controllers, batteries, inverters, wiring, and installation methods of PV systems. April 27–28: Solar Domestic Hot Water, Instructor: Chuck Gates of Altech Energy, Location: Forestville, WI, Cost: $225—Through hands-on demonstrations and an actual installation of a two panel system you will learn different types and components, siting, sizing, transfer fluids, and controllers for solar hot water systems. May 4–5: Grid-Intertie Wind Systems, Instructor: Mick Sagrillo of Lake Michigan Wind & Sun, Location: Milwaukee, WI, Cost $225—This workshop covers siting, system sizing, installation, zoning, and utility issues. For utility intertie wind systems in the 3 KW to 20 KW range. There will be several site visits of working systems and equipment will be on hand for demonstrations. MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration. Membership and participation in the MREA are open and welcome to all interested individuals and organizations. Significant others may attend

with you for 1/2 price. For more information call or write MREA, PO Box 249, Amherst, WI 54406; (715) 824-5166 phone (715) 824-5399 fax

The Tesla Builders Association (TEBA) is a non-profit information clearing house for those interested in energy conversion and hybrid electric vehicle applications using Nikola Tesla's high efficiency, turbo machinery. For more information send and SASE to: TEBA, 5464 N Port Washington Rd, Ste 293, Milwaukee, WI 53217

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17. I certify that the statements made by me above are correct and complete. Karen L. Perez, Publisher and Managing Editor 9/25/95.

the Wizard speaks...

Catastrophe

There are a few potential catastrophic scenarios being developed in regards to our planet and the life upon it. Here are four that I have come in contact with.

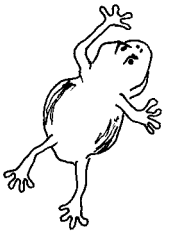
Ozone Depletion
A severely depleted ozone layer could interrupt the life-cycle of the vegetable kingdom. If plant life is severely curtailed, especially in the oceans, the oxygen content of the atmosphere could fall precipitously. This would make human life on the planet almost impossible.

Global Warming
There are three potential catastrophic results of global warming. Runaway global warming could produce surface temperatures in excess of 212° F making life virtually impossible. A melting of the polar ice caps could submerge all but the highest land areas. A third possibility is that of a new and severe ice age.

Disease
Lately, a variety of new diseases and mutated forms of old diseases have arisen. If a highly contagious form were to appear, the human population could be devastated. Pollution and overpopulation can contribute greatly to this possibility. They may also contribute to plant and animal diseases. New diseases may also arise in the earlier stages of the previous two scenarios.

Collision
In this scenario, there is a potential not only for the destruction of life but also for the destruction of the planet itself. This might occur if a large enough celestial body were to collide with the Earth.

Conclusion
All is not darkness and gloom. There is a light at the end of the tunnel. The first three scenarios are well within our power to prevent. We need only the will to act. The fourth is, however, in the hands of fate, for now.



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Letters to Home Power

California Net Metering

For those readers who have not already heard through the grapevine, I'm writing to follow-up on the status of SB 656, the California legislature's net metering bill that was the subject of my article in *HP*#46, page 72.

The good news is that the bill passed the legislature and was signed into law by Governor Wilson on August 3, 1995. The law is effective January 1, 1996, by which time utilities have to have tariffs or other standardized agreements in place to provide net metering to qualifying customer-generators.

The bad news is that the bill was amended in several respects as it worked its way through the legislature. These amendments, which further limit the availability of net metering, were allowed as a concession to those who opposed the bill. I'd like to to explain the amendments and their potential impact.

First, the availability of net metering was limited to customer-generators using solar energy (as a practical matter, this means photovoltaics). In the original bill, the list of qualifying customer-generators included those using wind and small hydro systems. But when the political opposition reared its ugly head, wind and hydro lost out. According to the folks at CalSEIA, who sponsored the legislation and strongly supported its run through the legislative gauntlet, there was very little independent constituency supporting wind and small hydro. In hindsight, I think we should have done more to encourage the American Wind Energy Association and other renewable energy advocates to keep wind and hydro in the bill. In any case, I was personally disappointed that this amendment was made. Of course, it may be possible to further amend the law in a future legislative session to include wind and hydro systems once again!

Second, the individual system size was limited to 10 kilowatts of peak generation capacity (down from 50 kilowatts) for each customer-generator.

Third, the overall availability of net metering was limited to 0.1 percent of each utility's anticipated 1996 peak demand (down from 0.5 percent).

The fourth and final amendment was the inclusion of a provision stating that the net metering law would be subject to further legal and regulatory changes imposed by the Public Utilities Commission or other regulating bodies in the course of electricity industry restructuring.

Contrary to what's been written elsewhere I don't consider any of the last three amendments to be significant changes to the bill. The individual system size already was implicitly constrained by other language in the bill, which limited the availability of net metering to residential customers whose generation is "intended primarily to offset part or all of the customer's own electrical requirements." Since very few residential customers use even 10 kilowatts of power at peak, much less 50 kilowatts, the reduction in system size will have little consequence.

Similarly, the reduction in availability to 0.1 percent of each utility's peak demand has little practical significance. Although 0.1 percent of peak doesn't sound like much, it amounts to 17 megawatts in PG&E;s service territory, and 2.6 megawatts in SMUD's (much smaller) service territory. Given the small number of grid-connected PV systems currently being sold, this leaves a lot of room for growth. In PG&E's service territory, for example, the growth cap is equivalent to 8,500 two-kW PV systems. My guess is there are no more than a handful of such systems in place today (remember we are talking grid-connected systems). Considering the tremendous changes that are likely to occur in the electricity industry over the next decade, I think it is highly unlikely that this cap will be reached before much more fundamental and far-reaching changes render the net metering law completely moot.

Finally, the restructuring amendment is essentially meaningless—it simply says that the net metering law is subject to the interpretation of the Public Utilities Commission and to modification by the legislature—which it would be anyway, with or without the inclusion of this language.

Given all this, I was a little disappointed in Michael Welch's description of the amendments as making the legislation "a mere shell of its former self." ("Season of Change," *HP*#48, page 78). Although I agree with Michael that net metering by itself won't make grid-connected PV economic, it is a very important first step. It provides customers with a price 2–4 times higher than otherwise available for excess electricity sold back to the utility, and it allows customers in most instances to use their existing electrical meters to hook up to the utility, substantially reducing metering and interconnection costs.

I think the biggest concern is that some utilities will violate the spirit, if not the letter, of the new law by placing additional obstacles in the path of enlightened customers who want to generate their own 'green' electrons. I have heard of stories about utilities imposing excessive and/or redundant safety standards, contractual obligations, and insurance requirements on potential customer-generators who are willing to pay the price for a simple rooftop PV system, but are unwilling to pay three times that price to hire the accountants, lawyers, and insurance agents needed to contend with the utility's unreasonable requirements. If any of you have similar experiences, particularly under the new law, please write me and let me know—these stories are a valuable tool for explaining to legislators and regulators how utilities use their monopoly power to unfair competitive advantage.

Finally, I want to note that many *Home Power* readers sent letters to the legislature expressing their support of the bill, and those letters were an important factor in the bill's passage. In fact, a number of legislators commented on the fact that there were over 43 letters in favor of the bill, and

only one against—from PG&E. This entire process has shown that grass-roots support for renewables can make a difference. Keep up the good work! Tom Starrs, 403 94th Ave SE, Bellevue, WA 98004, 206-454-4570; tstarrs@garnet.berkeley.edu

Thanks for clearing up many of the misunderstandings surrounding California Senate Bill 656. I agree—this bill is very important, even if it excludes wind and hydro systems. The big challenge that renewable energy faces is putting its power on to national electric grids. This bill is a big step forward. It empowers small independent producers. It supports "the going rate" or net billing (at least to parity) for independent RE producers. These are big concessions to rassle from the mega-utilities of California. I am glad that Home Power readers helped make this happen. This makes me happy—even though Home Power readers may be small in number, we are doers. Look out America, we have a better way—RE is coming!Richard Perez

The Water of Life

Haiti Mission, Inc. a non-profit organization, has been assisting the people of Cotin, Haiti towards a better and more sustainable lifestyle for the past eight years. Various mission teams have helped with construction, village industry and agriculture.

Two years ago, David Paulson approached me to plan a solar pumping system for this village. The residents, who are sharecroppers, now must walk two to three hours to obtain water from a contaminated surface source. The village contains 100 families. A little arithmetic tells us that 200 to 300 person-hours per day plus clean water can be gained with these pumps. These people work very hard and that extra time will enhance their lives greatly. The solar well pumps will be a historic step to positively change the health and future of Cotin.

The previous mission team drilled a six inch well and hit water at 140 feet depth. Due to the heavy rains, the team had to undertake some road repair to extricate the well rig and allow it and the support vehicles to reach the site and drill the well.

We are now accumulating components: two DC submersible well pumps, 300 watts of solar panels, LCBs, a tracker, spare parts, pipe and wire. We are looking for funding to assist with airfare to get the team and components down there. I would also like to see these people become acquainted with solar cooking, as they now cook with charcoal, when they can afford it.

The next team will deliver and install the solar well pump systems, construct eight benches for the church and school, and deliver clothing which will be used for equipment padding.

David and I are working on a video which shows the ruggedness of this region as well as some of the challenges of REAL remote power development. These videos will be available for a $30 or greater donation after the completion of the well installation.

As well as being an attempt to improve life in this village, I hope to use this as a laboratory to study problems and challenges of village development in third world environments. I plan to share more experiences with *Home Power* readers in the future.

If anyone would like to make a donation of equipment or money to help this group with their Haitian well project contact: David and Connie Paulson, Haiti Mission, 61 Pembroke St, Kingston, MA 02364, 617-585-6119 or me, Steve Pitney, Alternate Energy Inc, 60 Firehouse Rd, Plymouth, MA 02360, 800-327-6527, fax 800-659-5961

PVs Survive Hurricane

One week has passed since first Hurricane Luis and then Hurricane Marilyn totally devastated St. Thomas. The island is without grid power. It will be 4 to 6 months before normal power is restored. Things are in a big mess here! It is still hard to comprehend the extent of the destruction

I wanted to take time out to thank Zomeworks for making incredibly strong PV Mounting Racks. We have 30 PC4JFs mounted on them which survived the Hurricanes. Thank You! They are great products and I am 500% sold on them!

Wind gusts of 205 MPH were clocked at the airport. My home and architectural offices, where I weathered the storm, withstood hurricane force winds for at least 8 hours with wind gusts to 150 MPH. Immediately after the storm, I used the power from my PV system to saw and re-install part of the metal roofing that had blown off my house. Our PV system now supplies power for both my home and the CAD system in my architectural office and allows us to help begin the mammoth task of rebuilding St Thomas.

The other system, at my wife's medical supply company, Supply Resources Inc. (SRI), functioned throughout the storm providing power for the refrigeration of critical medical supplies, none of which were lost. Because she had power, she was able to re-open her business the day after the hurricane to provide medical supplies to the hospitals until emergency relief supplies could arrive.

Our systems were supplied and installed by our environmental products division of SRI, Caribbean Care.

Before the hurricanes, there was not much interest in solar electric power in St. Thomas because of the high initial cost. Because of our experiences, that may be changing. Last week, Caribbean Care sold two home PV power systems! Caribbean Care hopes to be able to quickly supply many more of Zomeworks fine products to the islands. Doug White, St Thomas, US Virgin Islands

More PVs Survive Hurricane

For most of us Hurricane Marilyn is already old news, but for the people of the Virgin Islands the story is far from over. I have just returned from an emergency visit to Saint Thomas and Saint John and can assure you that the newspaper accounts and television pictures you may have seen do not convey the scope of this natural disaster and the hardships it has brought to the islands.

When I arrived four days after the storm, the Saint Thomas airport was operating under what looked like war-time conditions. The trip across the island to the ferry was like traveling through a battle zone. Houses were flattened, construction debris and uprooted vegetation lay everywhere.

Arriving in Saint John, I was struck by an unaccustomed quiet and bareness. Marilyn's powerful winds had torn the roofs from houses and toppled trees. There was no electricity or regular phone service. Food, water, and gasoline were in short supply.

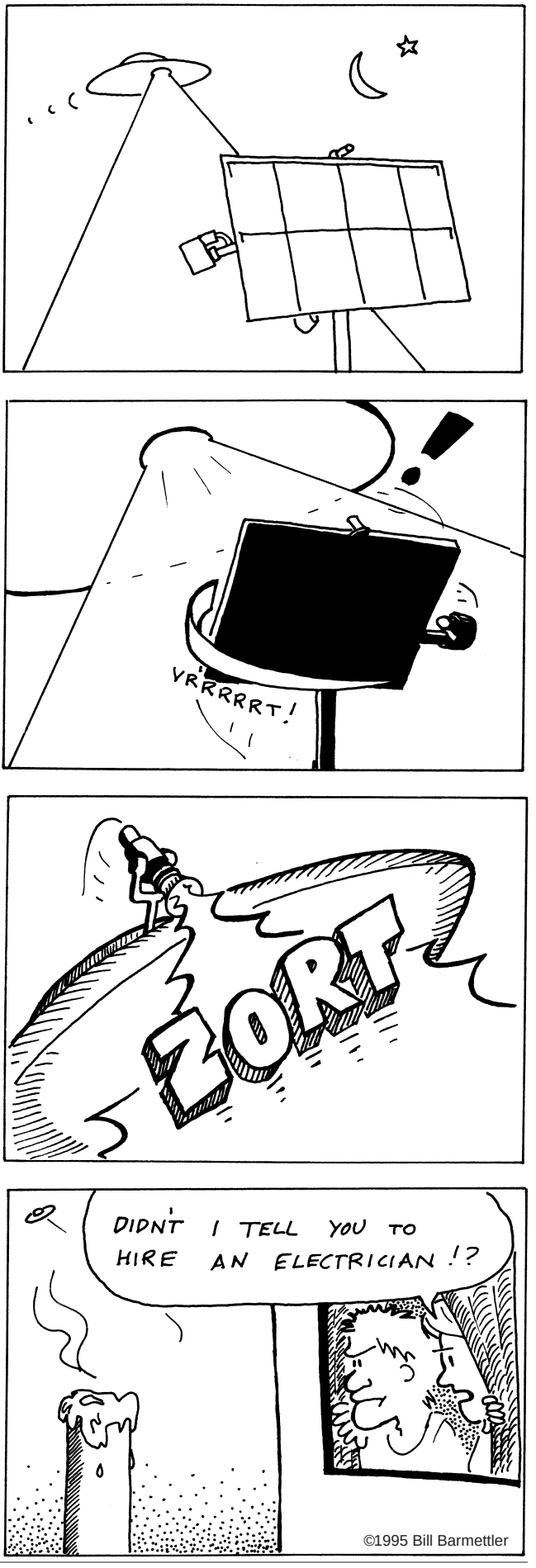
I had a pretty good idea about what I would find at Maho *(Part of a renewable energy powered resort).* Six years ago, Hurricane Hugo ripped the cloth coverings from the tents but left the frames largely intact. There was no power for lighting or pumping water to the bathhouses. We had to close down for six weeks until repairs could be made and facilities restored.

Marilyn left Maho in a similar state. But, to my surprise and delight, the new Harmony facility was not only unscathed, but operating. Its recycled building materials had withstood winds of more than 115 mph. Equally important, its self-sustaining power systems were working. Its banks of storage batteries never faltered and as soon as the storm passed and the sun came out the solar panels continued to recharge the systems.

The immediate benefit of this off-the-grid capacity was that Maho's staff never had to leave the campground. They moved into Harmony and were among the handful of Virgin Islanders who had light, refrigeration, hot showers, flush toilets and communication with the outside world.

The eco-tents at our Concordia resort on the other side of Saint Thomas also came through the storm with its self-contained utilities uninterrupted. There was a lot of flapping tent fabric, but I was able to stay in one of the units. It was something of a miracle to use an electric toothbrush, jump into a hot shower and sit on a working toilet when all about me there was darkness and disruption.

With a few repairs, the eco-tents were open for business by September 25th, nine days after taking a direct hit from a major hurricane. Restoring Maho Bay Camps will take longer, but we hope to have it operating by early November. On the



the 6th of that month, we still plan to host a conference at which members of the U.S. National Park Service and staff from the Virgin Islands Department of Planning and Natural Resources will meet with Maho's development team to design the first stage of the expanded Concordia prototype project.

Unavoidably, Marilyn will have an effect on our agenda. While no one would remotely argue that her ill wind blew any good, she did put our new concepts through a successful stress test and gave us new ideas about building in exposed environments. Although I always believed that sustainable development was good ecology and good business, I never thought it would allow my staff and me to survive in style. Stanley Selengut, President, Maho Bay Camps, Inc.

New Zealand Video
HELP We are currently researching and collecting new information on PV and wind generation systems to produce an educational video on the subject in New Zealand.

I would welcome any constructive comments (large or small) on installed systems, etc. Is there anyone out there who is willing to loan at minimum cost, completed videos on their own PV and wind systems. We would also be interested in swapping video information on New Zealand PV and wind systems.

We are currently the only experimental home in the South Island of New Zealand generating our own PV and wind. Alternative Energies Ltd., 74 Adamson Crescent, Invercargill, New Zealand voice and fax (64) (03) 217-4807

From the UK
I was interested in your Burr Oak, Kansas correspondent's letter regretting there was so much Green Politics in your magazine. The answer to that is that there are no "technical" questions. How we use and generate energy affects everything we do.

As a non-American, I admire your democratic constitution, but am puzzled that Americans make so little use of it. Many don't vote, and their politicians operate against the real needs of their voters. Why are so many Americans afraid to discuss real political issues? Surely, they aren't still brainwashed into thinking any criticisms of the standard way of doing things is Communism? This is not a democratic attitude, but a variety of totalitarianism.

One of the real faults of western science is that so many scientists operate only in a "technical" sphere . Western science is an offshoot of Islamic science (Bishop Grossteste, Roger Bacon, Albertus Magnus and so on) which paid more attention to the moral and religious context. Perhaps Green Politics is an attempt to restore these dimensions. E. G. Matthews (Not afraid to be named), Dorset, United Kingdom

Well, E.G., I'm with you here. As a fellow Limey (born Bedford, UK in April 1945), I too am puzzled by America's interia to change and frustrated by her refusal to consider new ideas on their merit. Renewable energy is "green", that's why many of us are making our power this way. Renewable energy is also self-sufficient, reliable and sustainable. It puzzles me why some America's folks perceive RE's attributes as a threat. I totally agree about Western Science's apolitical attitude—nerds are responsible for their creations. To demand anything less is to demean us all. All any of us can do is to weed our own garden—keeping on putting up those PV modules, wind turbines, and microhydros. This is surely a very effective way to make change. Richard Perez.

Working Cows
I first heard of *HP* about 14 months ago in the *New Farm* magazine. This spring New Farm stopped publishing rather than try to pass increased paper and postage costs on to subscribers. I'm glad you put the subscription rate up instead of following NFs route. My husband and I operate a seasonal grass dairy farm—a lot more energy efficient then conventional containment dairies, but to be sustainable we need to farm energy production. I'd like to see some articles on methane (small scale production & use). What little research I've seen from the ag community has been high cost, high tech, & large scale; aimed at big confinement dairies & not at all appropriate for our situation.

On the home front, the "Home & Heart" discussion on washing machines was good. I'd like to see information & comparisons on refrigerators. A feature on some relatively low initial cost and quick payback RE investments might encourage those of on tight budgets to get started.

Above all, keep the presses rolling! I don't want to lose another good magazine this year. Chase Tanner, Fredericksburg, Maryland

Thanks for the encouragement, Chase. We will keep the presses printing issues of Home Power. The information is too valuable to do otherwise. Our knowledge of working methane systems is limited, but then that's what Home Power is for—to share information. How about it, readers? Can anyone help the Tanners recycle the energy in cow manure? Richard Perez

Dear Home Power
Thank you very much for your great coverage of the Midwest Renewable Energy Fair. Credit for our success should be given to our faithful vendors, workshop presenters, and equipment donors, and the thousands of people who visit us every summer solstice. And a very special thanks goes to you, Karen and Richard, for your generosity and enthusiasm. Without your undying belief in us, we would have given up long ago. You two are the "spark" that keeps us alive.

One correction: this past Energy Fair was our sixth. Time flies with great friends! Mick Sagrillo, President, Midwest Renewable Energy Association

Aw, shucks, Mick. Thanks for the flowers. The Midwest Renewable Energy Fair is indeed the high point of our year. Sorry about missing the number of MREFs. You'd think we'd remember since we've been to every one, but time is one thing we seem to have trouble with. See you at the Fair! Richard and Karen Perez for the HP Crew

High School Dream
I am a seventh grader attending Mt. Greylock Regional High School. I have been interested in the subject of solar and electric vehicles ever since the 1987 World Solar Challenge. I

love to design battery-powered cars, and hope to build an electrathon racer. My dad and I have attended the Tour de Sol four times, and the Solar and Electric Vehicle Symposium once (where I met some of the G.M. people). I have also collected, read, and filed all the information that I could find on the topic.

My "dream" vehicle would use aluminum box beam construction, "ski suspension" (*HP*#44) and a slightly modified version of Michael Hackleman's series-parallel controller. I would use moped or small motorcycle wheels. (I tried making a rolling mock-up last year, with bike tires which gave less than satisfactory results.) How can I get the necessary funding for the project, and approximately how much will it cost to construct the vehicle? Can I realistically expect to do this, if none of my teachers have any direct experience in this field?

Thank you for the "Go Power" section! Ben Erickson, Williamstown, MA

Wow! You've seen FOUR Tour de Sol races? I'm envious! Okay, to answer some of your questions. This issue's article on solar cars confirms what an adventure it can be.

Okay, let's get to your questions. First, an Electrathon STYLE vehicle can be built low-buck for neighborhood operation. Use moped wheels for asphalt cruise. Use go-kart wheels for hard cornering on/off the road. Attend rallies for ideas, read articles—but rely on your self. Study the characteristics of hardware so you can find cheaper motors, switches, indicators, wire, connectors in surplus houses, or scrounge them from discarded machinery, i.e., washer, tv, stereo, and computers. For race-COMPETITIVE vehicles, expect to pay $200 for a motor (the Doran-Scott PM motor seems to be the hot choice), $300 for an electronic controller (a Curtis unit with regen will be out soon), $100-200 for batteries (The Sears Diehard (Marine) Gold, at 12v, meets the rule's 64 lb battery weight), and $100-500 for body/chassis parts. Sound like a lot of money? Work at jobs to earn it and you'll start with good components. Funding? Sponsors supply money for a good idea, or a person they know will COMPLETE the work. Honor thy sponsor(s). (Choose carefully. You will endorse who they are and what they do.) You will want your project to reflect positively on their involvement. Where will anyone see your finished vehicle? Race attendance may be small. Study the last year's worth of issues at the local weekly newspaper office for annual events—parades, car shows, Earth Day, etc—and scheule your vehicle to attend THIS year's event. Work with newspapers, tv and radio stations, or local cable access both to help solicit funds and sponsors, and to show progress with your project. Add tenancity, power of belief, and boldness to your vocabulary. You can do anything you want. Good luck. Michael Hackleman

Getting Educated

It has been several months since I heard Richard Perez on National Public Radio and we subsequently spoke on the telephone. I was trying to buy a very small island in the Bahamas and couldn't figure out how to make the telecommunications work with cellular and my need for modems and fax machines. You explained your radio telephone system and put me in touch with Carlson Electronics.

Well, Carlson was great and I am still negotiating with the Bahamin authorities to get the property under contact. We are absolutely committed to living there part time and I will keep you informed and also take advantage of your offer to look at my RE plans before I give my contractor the go ahead.

I also took your advise and ordered one years back issues and one year forward of *Home Power.* I can't tell you what a joy *Home Power* has been. My awareness of RE was limited to the little solar panel that operated my $10 calculator. Having spent 20 years of my business career dealing with utilities, mining companies, and the Fortune 500 from the view point of a recycling executive, I can appreciate the uphill battle in front of any of us whose eyes have been opened to the benefits of RE. Don't you just wish that you ruled the world and could mandate that we all begin to convert our energy needs? In reading just six issues of *Home Power* I feel like even I could come up with a better plan.

The real purpose of this letter is to tell you that reading six issues in a row was quite an experience. I feel like I now have a basic education and am a lot more hip on what I might want for my system. I started out thinking PV with a gas genny backup. Now I am investigating PV with a microhydro backup. I saw an ad and just got a brochure from Jack Rabbit Marine about their Aquar UW. There is a 150 foot wide channel; between the island and the mainland. The tide rises and falls three feet twice a day, so this might work; especially if we constructed a small concrete type venturi on the island side to hang the UW and funnel water. Have you ever tested this system? I seriously considered wind. However, with their hurricanes and us only being there four months per year, wind leaves me with an uneasy feeling. So look how picky I have become. See what a little education will do?

It struck me that *HP*#48 is different than the previous five issues. Is the magazine becoming more sophisticated or have I gained just enough knowledge to appreciate the writing more? It looks like you have some new advertisers and the reviews of the Trace 4024 and Statpower's charger were just excellent. The real measure of my knowledge will be when I understand even half of an article from "Code Corner."

I don't know what you have done or are now doing, but whatever it is; Keep It Up! I am now a fan and wonder if you send a copy of each issue to some of our legislators? If this is too expensive, I would be happy to make a donation to help out. You know how you see those "adopt a highway" signs? How about "adopt a senator"? Please let me know if I can help. I will be back in contact when I am ready to plan my system.

Thanks again for your help and for turning me on to RE. Kenny Fischer, Saint Louis, MO

Thanks for the flowers, Kenny. Both Karen and I feel that Home Power is our life's work. We are satisfied to have found our reason for living and we will do our very best. Home Power continually changes. We merely chronicle the doings of RE users worldwide. RE isn't just two hippies in a tepee anymore. It has clearly become the way we will make our

energy in the next century. We currently have an "Adopt A Library" plan (we pay half, you pay half, see the Advertisers Index, under Adopt A Library, on page 112 for the specifics). We'd love to also adopt legislators. What we need to be sure of is that the issue of HP will be actually assimilated by a thinking human. In the Adopt A Library deal we ask readers to first check with their public library and make sure that the library has space to handle Home Power. We need to have a similar assurance from legislators. We don't want HP ending up in landfills. If someone will actually read the information, then we will move heaven and earth to get a copy into their hands. Anyone got any specific ideas? Richard Perez

Vehicle of Change
I just discovered your magazine and was overjoyed. It educated me on subjects in the first minutes of reading. We are living in the countryside of NE Oklahoma, building a dome home and setting up an RE system. Being a native of Marin County, CA, solar panels & domes are normal things, but not to the people here. The one thing I would like to see is more workshops and educational things in this area. As we know, the greatest obstacle in the advancement of RE is that people don't think it works. My wife and I are quickly becoming a vehicle of change locally. Any help we can get benefits all. So if there are any classes, workshops, demo's, etc. in this state, I would love to know. Josh Wilkins, RR1 Box 143, Boynton, OK 74422

Well, Josh, we're pretty much at a roll-yer-own stage now. If there are not workshops and other educational events locally, then it must be time to organize one. Check out Solar Energy International (see ad index). They can often help with seminars and educational events. Other than that, we at HP can help promote these events. Richard

Double The Pleasure
Great magazine before, with "Go Power" even better. Well, I am finally off-grid. What a change for the better. Not only has it forced me to be more conscience of my energy usage but I get more enjoyment our of using it. I also now get double pleasure out of sun, wind, and rain as they recharge my batteries.

I have a 24 Volt system and would like some 12 Volt devices. I would like to know if the Vanner battery equalizer is something that works or if I should use a DC to DC converter. John Swatosh, Brush Prairie, WA

T*he Vanner Voltmaster works, John. See HP#41, page 16, for an article about a system that has been using the Voltmaster since the Spring of 1994. Efficiency is high, RFI is low, and the Voltmasters hasn't failed yet! Richard Perez*

HELP
Help! I own a Commuta-car EV. It has a bad rear wheel brake cylinder. Can anyone tell me where I can get a replacement part? I need this part to avoid the PR disaster of having to retire a working electric vehicle because of parts unavailability. Rich Meyer, 13416 CR 44, Millersburg, IN 46543

Restoration First
Great magazine! I really like everything especially "Things that Work!" It's wonderful that you're using chlorine-free paper. Also, I appreciate not being dunned with renewal notices!

My farm (60 acres on a hillside) was farmed out, overgrazed, & eroding when I got it, so restoring it to grass is the biggest priority. Solar power must wait. But I keep reading and learning, so it will just be that much better when I finally get it. Thanks for an excellent resource! Marion Williamson, Wilory Farm, Stonewall, TX

Diversity An Asset
I'm very pleased with the magazine's layout. I like the clean formatting of the articles, which themselves are well done. Taken along with page numbers on nearly every page, *HP* is a pleasure to read.

I personally am most interested in "Homebrew," PV and "Go Power" articles. If these were the only topics in *HP* though, it would not be the exceptional magazine that it is. Its diversity is clearly an asset.

I moved recently from the Big Island of Hawaii, where I rented a solar home for a year. I returned to the mainland slightly moldy (all my diskettes are ruined) and determined to 'roll my own' electricity, eventually. I was happy to see a few electric vehicles on the road in the Portland (Oregon) area. *HP* is my strongest link to the RE world, though, until I save a little money. Speaking of money...I'll be getting that CD-ROM of all the back issues—what a great idea! Michael Lapointe, Sherwood, OR

I am pleased that you are one of the very few who have noticed Home Power's layout. I have been doing graphics design since 1963 (Portsmouth, NH, High School newspaper), and my fondest wish is that our design become transparent. You won't see "continued on page XX" in Home Power. You won't see advertising in the middle of an article, interrupting its information flow. Home Power reads from front to back, with no jumping around. I know that this is not the way that most magazines are, but it's the way we are. Many thanks to our advertisers who have accepted and appreciated that the information comes first! Richard Perez.

Letters First
For years now I have been enjoying your magazine, reading the letters first, then the articles, then the ads; then looking forward to the next issue. My daughters say "Your blue magazine came today," since the sky is so prominent on your covers. I look to the letters first, as a forum between your readers: this splinter of the population interested in making renewable energy personal.

Most of the people I talk to about my stand-alone PV system require a 15 minute introduction to the subject to get past the idea that if I am not hooked up to the utilities I am living the primitive life, without electricity, or water, or who knows what else. Usually I point out that many hobbies, such as gardening or sewing are not necessarily to produce products cheaper or better, but to participate in our most basic existence. The fulfillment associated with raising sheep, spinning and weaving is just as available to those of us who design, install and maintain our energy systems, though I admit not many people will make a hobby out of all this tinkering, troubleshooting and toting heavy batteries that I

cherish. It is refreshing in *Home Power* articles to bypass this chaff and get to the grist. Even good articles in general interest magazines assume ignorance of off-the-grid existence.

On another, perhaps more sensitive subject, I would like to again emphasize that a slender sliver of the population we are. But what potential we have for leading to a sustainable future. Spotlighting those of us who have been successful through trial and error is appropriately each issue's lead article. Encouraging dialogue among us in the letters is, as I earlier suggested, perhaps the most valuable service I find in your periodical. Providing a venue for the manufacturers and suppliers of various equipment to reach us, their most preselected customer base, may be your most essential service to the big picture, successfully demonstrating that renewable energy is possible, practical and profitable. Randon States, Glen Ellen, CA

Wow, Randon, you have captured the essence of our purpose. We aim to provide no nonsense, techie info for all who are interested in renewable energy. If you were awake during high school science, then Home Power can help you understand and use renewable energy. This is our purpose. As you may have noticed, almost all of our articles are written by our readers, not by our permanent staff, we merely burp your experiences. While our section of the overall population may be slender, we are energetic and active. A thinking human that does is worth fifty that just eat. Richard for the Home Power Crew.

AC RV

Enclosed is my check for the first renewal of your highly competent magazine. I'm hoping that some of the future issues have articles specifically aimed to my type of solar home power use. No, I am not that unusual, there are tens of thousands of us, the difference is that our homes are on wheels and are moved around a great deal. We are the full timing RVers. Many boondock frequently and in my case I also have a home base in a trailer park with no electrical hook-ups. It caters to people who appreciate plenty of space for privacy and consequently the park covers a couple of square miles and therefore electrical hook-ups are too costly to install. The recent availability, and oh so suitable for us RVers, is the now very popular small dish digital satellite system (DDS). Now AC power is needed for it and its VCR, larger TV set (to make use of its higher resolution and DC quality sound) etc. It dictates the use of an inverter to supply the "must have" AC power. Generator use is becoming increasingly restricted, often to a few hours only, during the mid-day hours. I applaud this desirable trend to diminish the noise pollution. Add to this the generally poor electrical design layout, with low quality, inadequate electrical components with equally low quality installation, specially in the mid and low price RVs. It becomes obvious that the elegant solution in this situation is to change over to AC powered components. Benefits are many and obvious, for example using AC powered fluorescent lights lowers the cost and power consumption substantially. Appliances one already operates at home can be utilized, etc. It is interesting to note that the newer, high quality RVs are now starting to have all AC powered interior electrics. Therefore an occasional article about the integration and wiring changes when going from existing DC to AC would be of interest to many and it would expand your subscriber base but still be within the title of your magazine *Home Power.*

Any hope of some articles occasionally? I also invite anyone who has made such conversions or has suggestions or counterpoints to write me. Harry Melts, PO Box 9275, Why, AZ 85321

Well, Harry, the full blown RV system is not much different from the average HP system, except for space constraints. Inverters are the way to go! Even in an RV, with short wiring lengths, the distribution of 120 vac is easier, cheaper and more useful. If you are considering electronic loads such as Sat TV, VCRs, or radios, then use a pure sine wave inverter. I burped our subscriber's database and found that about 18% of our readers live in RVs. Once again, we report on your doings. How about it? Any readers running PV/inverter systems in their RVs (I know that there are hundreds of you out there, so consider this a challenge to share what you have learned). We will consider printing any coherent info about these systems. Richard

Nature's Coattails

Heard an radio interview with the Publisher, Richard Perez, on "To The Best Of Our Knowledge" a week or so ago, and was very intrigued with his comments. I greatly admire the self-sufficient approach described, and was fascinated by the level of technology now available. "Putting hooks into Nature's coattails" is a great quote which I've already passed on to a few people. I picked up a copy of *Home Power* on the newsstand, continued to be fascinated by your coverage, and decided to subscribe. So, you lose a newsstand buyer, but gain a subscriber. I look forward to future issues. All the best to you and your crew... Steve Willard, Hayward, CA

Thanks for subscribing, Steve. We also appreciate all of our reader who buy Home Power on newsstands. The newsstand is where we grow. While preaching to the choir is lotsa fun, we seek new converts. Newsstands around the world are where we are able to spread information about renewable energy to folks who have never considered these possibilities. Richard Perez

Mainstreaming PV

I was very happy to read Mark Whitaker's "Portland PV Power." I have felt for some time now that small, affordable, expandable, PV systems integrated with grid power are the best way to ease solar electricity into the mainstream. My experiences with solar electricity were born of necessity and I have the utmost respect for those who chose it voluntarily, motivated by something other than money. Bill Campbell, Peoples Solar Light & Power, Bolton Landing, NY

I hear you, Bill. Karen and I (and all of HP Central) are over $300,000 from the end of the utility power lines. It's easy for us to justify buying RE gear, it's a very small faction of the cost of running in the power lines (and paying the monthly power bills). Folks who refuse, or better yet, contribute their RE to the grid have my admiration. Richard

Thermoelectric Help

I am looking for information on thermoelectric generators. I

saw in *HP*#47 that you recommend an article in #36 by Steve Willey. Is his address or phone number available? I would appreciate any help you could give. Clayton Kaufman, Marion, SD

Hi Clayton, Steve Willey can be reached at Backwoods Solar Electric, 8530 Rapid Lightning Creek Rd, Sandpoint, ID 83864, 208-263-4290. Karen Perez

Battery Oversimplification
Wish you'd write an in-depth article on battery selection which takes in the following: price, price per amp, longevity, DOD efficiency, etc. Having some background in AE systems I don't feel Trojan L-16s are the best buy in batteries. It seems that us folks back east need lots more storage in a battery bank and some of the industrial batteries, such as forklift, phone (stationary) cells, or the Lineage 2000 are a better deal. In comparing batteries most people don't seem to consider charging efficiency in areas with less than optimum sun—the northeast. Battery sizing articles are oversimplified. One problem with the larger industrial battery banks is the length of time & difficulty equalizing them. I'd appreciate your thoughts on all this. Neil Markovitz, Lewisburg, WV

OK, Neil, I accept the challenge. During the next few issues, you will see articles about batteries in the depth that you desire. I know that I am at least two years behind on delivering my new Battery Book, but I will serialize what I have done in the next few issues. The subject of batteries is indeed far deeper that we have covered to date. Richard Perez

Mass Production & Standardization
As a reader (and now subscriber) for several years I had a thought I would like to share with the HP/RE industry.

It seems to me that a remarkable opportunity (in terms of the "human condition", helping prevent further human induced degradation in the environment, and making a decent amount of money) has appeared in the chaos and misery left by the recent hurricanes in the Caribbean. It is expected that electric power on St. Thomas and in parts of Puerto Rico will be out for months due to lines being down and damage at many generating and switching facilities. Here is the opportunity I see and how I propose it can be taken advantage of.

Some enterprising individual should look into packaging a standardized home power system; the system as I envision it would consist of a combination of PV and wind generation, batteries, inverter, and utility intertie hardware, and be retrofitable to an existing home with as little modification as possible (the addition of a small shed in the yard would be OK). Size the system to be able to run an "average" home (less air-conditioning) on battery for 3–5 days (no additional power input); this is about the time it can be expected to take before the homeowner will be in a position to repair the RE section of the system that will likely sustain damage in a storm (of course, if you can design it to survive a hurricane without damage, so much the better).

Assuming that the islanders learn from this experience and start building their homes in a manner more suitable for the weather they have and are likely to continue to experience (no, it's not global climate change—weather is cyclic, and has simply been in the very mild part of the cycle for the past 40 years or so...we are seeing a swing back to the way it was previously), then such a system, widely implemented, would not only make people more self-sufficient (and thereby reduce the human misery experienced when one is without power for extended periods), it would significantly reduce the need for additional electric generating capacity in the islands. This in turn would reduce the cost of importing oil to run the generators (and its associated trade deficit, which is how you sell the idea politically), and of course reduce pollution in the process.

The purpose of the utility intertie is multi-faceted; 1) it makes it possible for homeowners to run 'extreme' loads, such as air-conditioning, while keeping the system affordable. 2) it lets your average person, one who is not yet experienced in the ways of 'aggressive' energy conservation to become involved in the RE arena (and with the possibility of saving and making money people will become the best conservers you can imagine); 3) it helps offset the cost by being able to sell the power back to the utility company when you have excess (which also will help the power company by relieving them of the need for major investments in new capacity), and 4) it helps keep the power company from felling threatened (and hence being likely t try and kill the plan).

The primary piece of data needed for this plan to work is to determine what a typical islander uses for electricity. Once you know that, you can design a system, price it out, and then look into selling it. If designed, packaged and marketed correctly, it is entirely conceivable that you can even be able to sell it to the Federal Emergency Management Agency as something the Government might be inclined to help finance the purchase of,m as it will pay dividends in the long run by helping to reduce the cost of their response to the NEXT disaster (and you can be sure there will be another one; such things are sadly inevitable when people ignore nature when choosing where to live).

One of the things that limits the spread of home power is the need to have your system individually designed and crafted for your specific application. This is not the way to go for minimal cost. We should take a lesson from two giants in the world of mass production and standardization:

• Henry Ford thought that standardization and mass production would lead to very low costs and high quality. The Model T proved him correct, and he revolutionized the world we live in (I don't intend to debate the relative merits of the automobile here; just acknowledge the reality of what Ford accomplished), and he made a lot of money to boot.

• The French Government decided in the early 1970's that their country would be 100% nuclear power by the year 2010 (Again, I do not intend to debate the merits of the issue, just the specific results). To do this they settled on a completely standardized power plant, which they have mass produced. The result is that they will achieve their goal by 2010, and at a cost that makes our power industry green with envy (that our power industry is too stupid to use the same logic of mass production and standardization is a sad commentary on the people running the industry...). The French have also managed to maintain a very high standard in their safety and

training; having one universal power plant design allows for consistent and transferable training; if you can run one plant, you can run another...it's the same. In the case for what I suggest above, a standardized system would allow for an installer to get VERY good at it in a short time. It would also allow the development of sophisticated documentation, training and selling tools (like video tapes, etc.). After all, the major cost these systems entail would be spread over the largest possible sales base.

Perhaps the HP/RE industry should look at forming a consortium to market something like this. If it takes off in St. Thomas (remember, they are the US Virgin Islands) then the product would also be marketable in the "lower 48". Such mass production and marketing would lower the costs of all of us. In my humble opinion, the large part of the future of electric power in this country lies in a combination of large utility plants and distributed (home) generation from RE, all tied together on the grid. There is nothing like a major disaster to overcome the inertia of the system and to get the Government to make decisions (or more likely simply to allow new ideas) that would otherwise never see the light of day. Thomas A, Frank, Middletown, RI; TAFrank@genie.com

We share a common vision, Thomas. Standardization is currently hampered by the high cost of RE gear. It is not cost effective to generate more than you can use, hence the custom design of each system. With utility intertie and increased RE product production, standardization becomes effective. Someone has to begin this process of development, and here we are…. Richard Perez

Q&A

Cabin Alarm— An Answer

I noticed your Q&A reply on page 108 of issue #49. You suggested that a reader could construct for under $100, a remote alarm for his cabin that would operate on 12 Volts.

I have used a similar solution that used to be available off-the-shelf from Radio Shack for $100, ready to use. However, this year the only model offered is 49–722 for $200. This alarm has more useless features than the old $100 version, but is the only one left with a pocket pager remote that beeps when the alarm is activated. With a non-directional 108" CB whip we used the pager over 2 miles away. A 3 to 5 element CB beam antenna would do even better. It can be activated by door switches and other sensors, or contains its own vibration sensor that would be more useful on a vehicle than for a cabin alarm. This is a good working system available off-the-shelf.

Medical Alarm—Friends of ours have linked one of these paging alarms with a wireless doorbell (rectify the audio output to pull small relay to start alarm transmitter) to make a health call alarm for their aging mother, who lives nearby in her own house. She wears the doorbell transmitter as a pendent which signals the doorbell chime which is linked to the auto alarm and pager. Thus they can be alerted to a medical emergency while still being free to move about and do errands within a few miles of home. The wireless doorbell costs about $20.00–30.00.

Or if you have a phone line available, instead of the wireless doorbell, you can use a real med-alert dialer (#61-2659 for $100, has alarm output to relay trip alarm), that dials a phone number for help, and can also be linked to the auto alarm pager for wireless coverage.

Steve Willey, Backwoods Solar Electric Systems, 8530 Rapid Lightning Creek Rd, Sandpoint, ID 83864, 208-263-4290

Thanks for the solution, Steve. Richard

PV Performance

While reading the article on PV panel; performance (HP#49, page 28), a thought kept flashing through my mind. What are the chances of these panels performing better after five years of service? To the best of my knowledge, this is not even possible. (I thought the best one can hope for is no degradation.)

Since the changes are only a small percentage, (about 1% or so), I finally dismissed it, but I thought you might want to address it in the magazine. Others may not have scrutinized it as I did. Folks should realize that while PVs can perform better depending on conditions, one cannot expect improved performance over time.

Keep the great alternative energy news coming! Kelly Larson, Reno, NV

Well, Kelly, we wondered the same thing. Why did this round of testing show slightly increased performance from all the modules? All we can figure out is that we changed the test jig from four Fluke 87 DMMs (and a chipboard for data logging) to a Remote Measurement Systems ADC-1 analog to digital converter which logs directly into a computer. We electrically calibrated the ADC-1 using the Flukes. The old manual test jig had about a 10% margin for error. We estimate that the new A/D jig has an error factor of around 5%. The A/D gives us over 400 data points per module, while the old manual jig gave us about 60 data points per module. Also, the Li-Cor pyranometer has a rated error factor of 5%. Bottom line is that the small performance increases we reported are within our window of experimental error.

If any of these PV modules have degraded over time, then the amount is so small as to be unmeasurable by our equipment. I think that the latest round of testing is more accurate than any of the previous tests. It will be interesting to make the same measurements, using the same test jig and modules, next summer. Richard Perez

Inverter Rating & Efficiency?

1. If the continuous power demand comes real close to a continuous power draw rating of an inverter is it then advisable to move up a step to a bigger inverter? Example: Exeltech 500 being operated at 480–490 Watts continuously.

2. How is efficiency affected near full load vs. 1/2 load? Harry Melts, Why, AZ

Hi, Harry. The answer to your question depends on the brand and model of inverter and your ambient temperatures. Some inverters are still time derated, others are rated at a continuous figure. All are derated at high (over 120°F) operating temperatures. The Exeltech you mentioned is a good example of realistic, solid rating. When Exeltech says 500 Watts, they mean 500 Watts continuous at room temperature (less than 95°F). We have been running three full-blown Macintosh publishing systems on a 1,000 Watt Exeltech. Their consumption is constantly between 900 and 1,000 Watts. The Exeltech has never shut down.

In the case of the Exeltechs, half load efficiency is about 85% while full load efficiency is about 82%. This is a very small difference. Other inverters will have different characteristics, so check the maker's specifications for the particular model you are considering. Richard Perez

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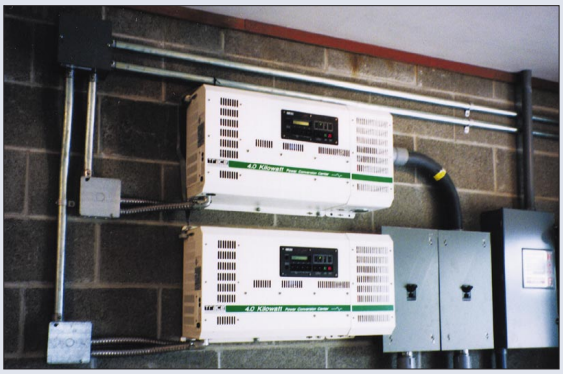

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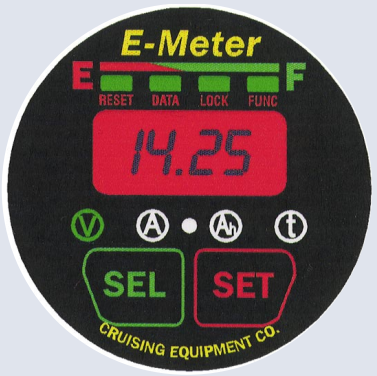

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